UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

OFFICE OF CHEMICAL SAFETY AND POLLUTION PREVENTION

[SEQ CHAPTER \h \r 1]MEMORANDUM

DATE: June 8, 2018, updated September 18, 2018

SUBJECT: Crop Grouping – Part XX: Analysis of the USDA IR-4 Petition to Amend the Crop Group Regulation 40 CFR § 180.41 (c) (22) and Commodity Definitions [40 CFR 180.1 (g)] Related to the Crop Group 15: Cereal Grains and the Forage, Fodder and Straw of Cereal Grains Group 16 [40 CFR § 180.41 (c) (23)], and Commodity Definition "Grasses for Sugar and Syrup Production."

PC Code: NA	DP Barcode: NA
Decision No.: NA	Registration No.: NA
Petition No.: NA	Regulatory Action: Crop Grouping Regulation
Risk Assessment Type: None	Case No.: NA
TXR No.: NA	CAS No.: NA
MRID No.: MRID 495774-00, 495774-01	40 CFR: 180.41 (c) (22), 180.41 (c) (23) and, 180.1 (g)

FROM: Bernard A. Schneider, Ph.D., Senior Plant Physiologist Bernard A. Schneider, Ph.D.
Chairperson Crop Group/Commodity Definition Focus Group
Chemistry and Exposure Branch, Health Effects Division (7509P) and
William P. Barney, Senior Coordinator, Food, Crop Groups, Biopesticides,
USDA IR-4 Project

TO: Sheila Piper and Danette Drew, Chairpersons
HED Chemistry Science Advisory Council (ChemSAC)
Health Effects Division (7509P) and Members

Jennifer Selwyn, and Monica Le, and Susan Wong, Health Canada, PMRA

Alma Liliana Tovar Díaz, Deputy Director of Certification and Recognition
Senasica-Sagarpa, Mexico

Nancy Fitz, Minor Use Officer, Minor Use and Emergency Response Branch (MUERB), Registration Division (7505P)

Ryne Yarger, Policy and Regulatory Services Branch, Field and External Affairs Division (7505P)

CC: IR-4 Project, Jerry Baron, Dan Kunkel, Debbie Carpenter, Van Starner

ACTION REQUESTED:

William P. Barney, Crop Grouping Project Coordinator, USDA Interregional Research Project No. 4 (IR-4), State Agricultural Experiment Station, Rutgers University has submitted a petition dated February 18, 2014 on behalf of the IR-4 Project, and the International Crop Grouping Consulting Committee (ICGCC) to amend the Crop Group 15: Cereal Grains and the Forage, Fodder and Straw of Cereal Grain Group 40 CFR § 180.41 (c) (22), PR # 11394, MRID No.: 495774-00 and 495774-01.

The USDA IR-4 Cereal Grain 15 and the Forage, Fodder and Straw of Cereal Grain Group 16 petition requested the following six proposals:

IR-4 Proposals:

1. Does ChemSAC concur with IR-4 proposal to amend the Cereal Grains Crop Group 15 and Forage, Fodder and Straw of Cereal Grains Crop Group 16 names to Cereal Grain Crop Group 15-19 and Forage, Hay, Stover, and Straw of Cereal Grain Crop Group 16-19?

2. Does ChemSAC concur with the IR-4 proposal to revise the Cereal Grains Crop Group 15 and Forage, Fodder and Straw of Cereal Grains Crop Group 16 from 14 commodities to 60 commodities?

3. Does ChemSAC concur with the IR-4 proposal to create five subgroups for Cereal Grains Crop Group 15 including 15A Wheat subgroup; 15B Barley subgroup; 15C Corn subgroup; 15D Grain sorghum or millet subgroup; and 15E Rice subgroup?

4. Does ChemSAC concur with the IR-4 proposal to keep the current representative commodities (wheat, field corn, sweet corn; grain sorghum and rice), with the addition of barley as a representative crop and that they will also be representative commodities for the amended crop subgroups, and the addition of proso millet as an alternate commodity to grain sorghum?

5. Does ChemSAC concur with the initial IR-4 proposal that one new commodity definition [40 CFR § 180.1(g)] will be needed for this amended crop group for sugarcane which will cover sweet sorghum to harmonize with Codex (See Table below)? Also, IR-4 feels the current commodity definitions are adequate, and do not need changing.

6. Does ChemSAC concur with the IR-4 proposal to add additional commodities to Forage, Fodder and Straw of Cereal Grain Crop Group 16 and without the creation of any subgroups? The Crop Group 16 name should be changed to Forage, Hay, Stover and Straw group to be consistent with current terminology.

BACKGROUND:

William P. Barney, Crop Grouping Project Coordinator, USDA Interregional Research Project No. 4 (IR-4), State Agricultural Experiment Station, Rutgers University has submitted a petition dated February 18, 2014 on behalf of the IR-4 Project, and the International Crop Grouping Consulting Committee (ICGCC) to amend the Crop Group 15: Cereal Grains and the Forage, Fodder and Straw of Cereal Grain Group 40 CFR § 180.41 (c) (22), PR # 11394, MRID No.: 495774-00 and 495774-01.

The revised Cereal Grain and Forage, Fodder and Straw of Cereal Grain crop group proposals were initiated at the USDA/IR-4 Crop Grouping Symposium in Washington, DC, October 2002. This workgroup was Chaired by Marija Arsenovic USDA IR-4 and Co-Chaired by Dr. Dudley Smith, Professor and Dean, Texas A&M University as well as Danette Drew, Dave Soderberg and Robert Travaglini, EPA.

The revised crop group was further discussed and developed within the Cereal Grains and Forage, Fodder and Straw of Cereal Grains Workgroups of the ICGCC. These workgroups consisted of 47 U.S. crop or regulatory experts from agriculture commodity groups, universities, agrichemical industry, IR-4 Project, USDA and EPA, and 77 international crop or regulatory experts representing 27 countries. The Workgroups discussed additional crops and validated each of the proposed commodities.

In the current US system, there are no subgroups in either Cereal Grains Crop Group 15 or in Forage, Fodder and Straw of Cereal Grain Crop Group 16. While the 2002, IR-4/USDA International Crop Grouping Symposium proposed six subgroups including (1) small grains subgroup, (2) corn subgroup, (3) rice subgroup, (4) sorghum subgroup, (5) rice and wheat subgroup and (6) grain corn and sorghum subgroup, the International Crop Grouping Consulting Committee is proposing three subgroups based on consideration of criteria for crop grouping and selection of representative crops and feedback from US EPA ChemSAC.

In 2014, ICGCC discussed additional commodities, possible subgroupings and representative commodities for Cereal Grains Crop Group 15. Four different proposals for subgroups were received and discussed by the ICGCC. These proposals along with supplemental wheat and barley tolerance information were submitted for consideration by US EPA ChemSAC. At that time (see [HYPERLINK \l "_ChemSAC_Meeting_Minutes,"] of October 29, 2014), ChemSAC concurred that only wheat should remain as a representative commodity rather than "wheat or barley" or "wheat and barley". Reasons that ChemSAC did not recommend having barley as an additional representative commodity or as an alternative commodity to wheat in the Cereal Grain crop group revisions were: based on large amount of harvested acres (14.3X) for wheat over barley; larger number of field trials currently required for wheat (20) over barley (12); much wider geographical and field trial distribution for wheat; differences in processed food and feed commodities with wheat having more items; different animal feeds would not reflect the extensive ones we have presently; crop group 16 considerations; massive differences in consumption of wheat over barley; large amount of USDA PDP data showing more detects in wheat than barley; and additional costly regulatory requirements on registrants and EPA review time by scientists if barley was added as a representative commodity.

Subsequently, the ICGCC received one comment from a registrant noting that not having barley as a representative crop could present trading issues since most other countries including Canada include barley as a representative crop. After the ChemSAC decision, Health Canada Pest Management Regulatory Agency (PMRA) also provided additional following comments to the ICGCC supporting the use of wheat and barley as representative commodities:

(a) MRLs established for barley based on wheat data may underestimate actual residues on this commodity. In Canada, there are 7 pesticides with higher MRLs for barley than for wheat. In comparison, there are only 3 pesticides that have higher MRLs for wheat than for barley. MRLs in barley were up to 16.7x higher than the MRLs for wheat for chemicals with the same registered use pattern. In the US, there are 8 pesticides with tolerances on barley that are higher than wheat and 4 pesticides with tolerances on wheat that are higher than for barley. In the EU, there are 41 pesticides with higher MRLs for barley than wheat and only 9 pesticides with higher MRLs for wheat than for barley.

(b) Barley production in Canada, while less than wheat, is greater than barley production in the US (9 million acres versus 4 million acres) and was considered as a representative crop for the original cereal grains crop group. Ratio of wheat to barley production in Canada is approximately 3:1 so barley is an important crop in Canada. Ratio of wheat to barley production in the US is approximately 11:1 (based on 2002 production data); 15:1 based on 2013 production data.

(c) In Europe, for uses close to harvest, the EU requires separate residue data for barley and wheat.

Recommendations from PMRA included (1) establishing wheat and barley as representative commodities; (2) propose a total of 20 trials for both representative commodities (i.e. 12 trials for wheat, 8 trials for barley) when a subgroup is proposed. If only wheat or barley were proposed, then the full number of trials would be required; (3) create a subgroup for corn, millet and sorghum with only sweet corn or field corn chosen as representative commodities. Canada does not grow grain sorghum, but alternatively, millet could be a representative crop, since there is sufficient production of millet in Canada with field trial requirements already established.

The Electronic Working Group (EWG) on the revision of the Codex Classification of Food and Animal Feeds, chaired by the U.S. (Bill Barney, USDA IR-4) and co-chaired by the Netherlands, held extensive discussions regarding Codex Cereal Grains Group 020 in 2014 through 2018.

In 2015, in the 47th Session, the Codex Committee on Pesticide Residues (CCPR) noted general agreement that sweet corn would be included in a separate subgroup and rice would also be included in a separate subgroup. The EWG was asked to discuss the issues of pseudocereal and wheat and barley and provide rationale for separating wheat and barley into separate subgroups based on the criteria for crop grouping.

In 2016, in the 48th Session, CCPR discussed two compromise proposals submitted by the EWG and created five subgroups for Cereal Grains Group 020 including Subgroup 020A, Wheat, similar grains, and pseudocereals without husks; Subgroup 020B, Barley, similar grains, and pseudocereals with husks; Subgroup 020C, Rice cereals; Subgroup 020D, Maize, grain sorghum and millet; and Subgroup 020E, Sweet corn cereals. This decision created a separate subgroup for barley and also precluded the creation of a separate subgroup for pseudocereals.

In 2017, in the 49th Session, CCPR created and adopted six subgroups for Cereal Grains Group 020 including Subgroup 020A, Wheat, similar grains, and pseudocereals without husks; Subgroup 020B, Barley, similar grains, and pseudocereals with husks; Subgroup 020C, Rice cereals; Subgroup 020D, Grain sorghum; Subgroup 020E, Maize; and Subgroup 020F, Sweet corns (see Appendix 1, Table 1). The rationale for separating grain sorghum and millet from maize (field corn) was because of the higher residues in grain sorghum compared to corn.

An important aspect of developing this revised crop group was harmonization with the Codex Crop Classification of Foods and Animal Feeds. The Codex classification system is currently under revision and revisions to the US system are used as a basis for the Codex revision. The IR-4/EPA Crop Grouping Working Group and the ICGCC collaborates with the revision of the Codex crop classification. The Codex Classification of Foods and Animal Feeds includes cereal grains in Group 020, Cereal Grains (see Appendix 1, Table 1), while straw, fodder and fodder of cereal grains are included in Group 051, Straw, fodder and forage of cereal grains and grasses, except grasses for sugar production (including buckwheat fodder).

Adding these commodities into a group will benefit growers by enabling tools for crop protection. Many minor cereal grain orphan crops have become more popular in the US and other countries and regions today than they were twenty-four years ago. Some of these "minor" crops have great potential to be grown on a larger scale in some areas in the future due to their unique nutritional and medicinal values. Being excluded from the crop groups, means that tolerances requested for these commodities would have to be established based on separate residue studies. Also, this crop group regulation will facilitate the establishment of pesticide tolerances on numerous pesticides that are needed to control a wide diversity of cereal grain pests, as well as developing integrated pest control (IPM) programs to incorporate reduced risk pesticides and biopesticides, and to reduce the development of pesticide resistance. Because the demand for cereal grain crops keeps increasing in the United States, these crops may provide local market growers new revenue opportunities with high returns per acre.

HED RECOMMENDATIONS:

Each of the proposals and recommendations will be discussed below, followed by a series of other recommendations on terminology, database development, and harmonization with Codex. The EPA would like to commend the valuable and high quality input of the ICGCC, all its members, and the Committee Chairperson Bill Barney, USDA IR-4 and Keith Dorschner, USDA IR-4, as well as Bill Hazel, Sheila Piper, and Dr. Yuen-Shaung NG, US EPA; Vera Au, and Jessie Cordova, HED, Barbara Madden, Biologist, RD, EPA for leading the initial workgroup and for input and development of various databases in this report and Dr. Paul Schwartz, USDA, Office of Minor Use Pesticides for his advice, peer review, and research office location.

IR-4 Proposal 1:

> "Does ChemSAC concur with the IR-4 proposal to amend the Cereal Grains Crop Group 15 and Forage, Fodder and Straw of Cereal Grains Crop Group 16 names to Cereal Grain Crop Group 15-19 and Forage, Hay, Stover, and Straw of Cereal Grain Crop Group 16-19?"

HED ChemSAC Recommendations for Proposal 1:

Corn fodder is an antiquated term since the term refers to the entire corn plant used fresh or dried and includes the ears. Modern harvesting methods since 1950's remove the ear at harvest and leave the whole stalk that is called stover. We should replace fodder with stover to update the commodity terminology. Fodder terms for most cereal grains including all the representative commodities has no meaning.

Under the Phase IV Crop Group Regulation Section (26) (ii) EPA may establish separate group tolerances on forage or hay, if data on the representative commodities indicate differences in the levels of residues on forage and hay: [Pesticide Tolerances: Crop Grouping Program Amendment IV May 3, 2016 (EPA-HQ-OPP-2006-0766-0085, FR No. 2016-10319)]

IR-4 Proposal 2:

> "Does ChemSAC concur with the IR-4 proposal to revise the Cereal Grains Crop Group 15 and Forage, Fodder and Straw of Cereal Grains Crop Group 16 from 14 commodities to 60 commodities?"

Current Crop Group:

1. Barley (*Hordeum* spp.)
2. Buckwheat (*Fagopyrum esculentum*)
3. Corn (*Zea mays*)
4. Millet, pearl (*Pennisetum glaucum*)
5. Millet, proso (*Panicum milliaceum*)
6. Oats (*Avena* spp.)
7. Popcorn (*Zea mays* var. *everta*)
8. Rice (*Oryza sativa*)
9. Rye (*Secale cereale*)
10. Sorghum (milo) (*Sorghum* spp.).
11. Teosinte (*Euchlaena Mexicana).*

12. Triticale (*Triticum-Secale* hybrids).
13. Wheat (*Triticum* spp.).
14. Wild rice (*Zizania aquatic).*

Proposed revised Crop Group 15 Cereal Grains and Crop Group 16 Forage, Hay, Fodder and Straw of Cereal Grains that consists of the following commodities with the new proposed commodities highlighted in blue:

1. Amaranth, Grain, *Amaranthus* spp.
2. Amaranth, Purple, *Amaranthus cruentus* L.
3. Baby corn, *Zea mays* L. subsp. *mays*
4. Barley, *Hordeum vulgare* L. subsp. *vulgare*
5. Buckwheat, *Fagopyrum esculentum* Moench
6. Buckwheat, Tartary, *Fagopyrum tataricum* (L.) Gaertn.
7. Canarygrass, annual, *Phalaris canariensis* L.
8. Cañihua, *Chenopodium pallidicaule* Aellen
9. Chia, *Salvia hispanica* L.
10. Corn, field, *Zea mays* L. subsp. *mays*
11. Corn, sweet, *Zea mays* L. subsp. *mays*
12. Cram-cram, *Cenchrus biflorus* Roxb.
13. Fonio, black, *Digitaria iburua* Stapf
14. Fonio, white, *Digitaria exilis* (Kippist) Stapf
15. Huauzontle, grain, *Chenopodium berlandieri* Moq. subsp. *nuttalliae* (Saff.) H. D Wilson & Heiser and *Chenopodium berlandier*
16. Inca wheat, *Amaranthus caudatus* L.
17. Job's tears, *Coix lacryma-jobi* L.
18. Millet, barnyard, *Echinochloa frumentacea* Link.
19. Millet, finger, *Eleusine coracana* (L.) Gaertn. subsp. *coracana*
20. Millet, foxtail, *Setaria italica* (L.) P. Beauv. subsp. *italic*
21. Millet, little, *Panicum sumatrense* Roth
22. Millet, pearl, *Pennisetum glaucum* (L.) R. Br.
23. Millet, proso, *Panicum miliaceum* L. subsp. *miliaceum*
24. Oat, *Avena spp.*
25. Oat, Abyssinian, *Avena abyssinica* Hochst. ex A. Rich.
26. Oat, common, *Avena sativa* L.
27. Oat, naked, *Avena nuda* L.
28. Oat, sand, *Avena strigosa* Schreb.
29. Popcorn, *Zea mays* L. subsp. *mays*
30. Princess-feather, *Amaranthus hypochondriacus* L.
31. Psyllium, *Plantago arenaria* Waldst. & Kit.
32. Psyllium, blond, *Plantago ovata* Forssk.
33. Quinoa, *Chenopodium quinoa* Willd. subsp. *quinoa*
34. Rice, *Oryza sativa* L.
35. Rice, African, *Oryza glaberrima* Steud.
36. Rye, *Secale cereale* L. subsp. *cereal*
37. Sorghum, grain, *Sorghum bicolor* (L.) Moench
38. Teff, *Eragrostis tef* (Zuccagni) Trotter

39. Teosinte, *Zea mays* L. subsp. *mexicana* (Schrad.) H. H. Iltis.
40. Triticale, X *Triticosecale* spp.
41. Wheat, *Triticum* spp.
42. Wheat, club, *Triticum aestivum* L. subsp. *compactum* (Host) Mackey
43. Wheat, common, *Triticum aestivum* L. subsp. *aestivum*
44. Wheat, durum, *Triticum turgidum* L. subsp. *durum* (Desf.) van Slageren
45. Wheat, einkorn, *Triticum monococcum* L. subsp. *monococcum*
46. Wheat, emmer, *Triticum turgidum* L. subsp. *dicoccon* (Schrank) Thell.
47. Wheat, macha, *Triticum aestivum* L. subsp. *macha* (Dekapr. & Menabde) Mackey
48. Wheat, oriental, *Triticum turgidum* L. subsp. *turanicum* (Jakubz.) Á. Löve & D. Löve
49. Wheat, Persian, *Triticum turgidum* L. subsp. *carthlicum* (Nevski) Á. Löve & D. Löve.
50. Wheat, Polish, *Triticum turgidum* L. subsp. *polonicum* (L.) Thell.
51. Wheat, poulard, *Triticum turgidum* L. subsp. *turgidum*
52. Wheat, shot, *Triticum aestivum* L. subsp. *sphaerococcum* (Percival) Mackey
53. Wheat, spelt, *Triticum aestivum* L. subsp. *spelta* (L.) Thell.
54. Wheat, Timopheevi, *Triticum timopheevii* (Zhuk.) Zhuk. subsp. *timopheevii*
55. Wheat, Vavilovi, *Triticum vavilovii* Jakubz.
56. Wheat, wild einkorn, *Triticum monococcum* L. subsp. *aegilopoides* (Link) Thell.
57. Wheat, wild emmer, *Triticum turgidum* L. subsp. *dicoccoides* (Körn. ex Asch. & Graebn.) Thell.
58. Wheatgrass, intermediate, *Iseilema prostratum* (L.) Andersson
59. Wild rice, *Zizania palustris* L.
60. Wild rice, Eastern, *Zizania aquatica* L.

    Cultivars, varieties, and hybrids of these commodities.

Of the new commodities in blue, 21 are more specific terms for commodities that are already covered by terms in the current crop group (i.e., baby corn and the different varieties of oat and wheat). The following 24 commodities are not covered by terms in the current crop group: amaranth, purple amaranth, Tartary buckwheat, annual canarygrass, cañihua, chia, cram-cram, black fonio, white fonio, huauzontle, Inca wheat, Job's tears, barnyard millet, finger millet, foxtail millet, little millet, princess-feather, psyllium, blond psyllium, quinoa, African rice, teff, intermediate wheatgrass, and eastern wild rice.

HED ChemSAC Recommendations for Proposal 2:

We agree with proposed list of commodities submitted by IR-4. These commodities are based on similarities of growth habits and edible plant parts (grain, seeds, or achenes) that are exposed similarity to pesticides, wide geographical distribution, comparison of established tolerances, and for international harmonization purposes; it is recommended that ChemSAC concur to amend the Crop Group 15 Cereal Grains and Crop Group 16 Forage, Fodder and Straw of Cereal Grains with 60 commodities.

Adding these commodities into a group will benefit growers by enabling tools for crop protection. Many minor cereal grain orphan crops have become more popular in the US and other countries and regions today than they were twenty-four years ago. Some of these "minor" crops have great potential to be grown on a larger scale in some areas in the future due to their unique nutritional and medicinal values. Being excluded from the crop groups, means that tolerances requested for these commodities would have to be established based on separate residue studies. Also, this crop group regulation will facilitate the establishment of pesticide tolerances on numerous pesticides that are needed to control a wide diversity of cereal grain pests, as well as developing integrated pest control (IPM) programs to incorporate reduced risk pesticides and biopesticides, and to reduce the development of pesticide resistance. Because the demand for cereal grain crops keeps increasing in the United States, as well as older varieties becoming mainstream such as spelt wheat and emmer wheat (popularly called farro). These crops may provide local market growers new revenue opportunities with high returns per acre.

IR-4 Proposal 3:

> "Does ChemSAC concur with the IR-4 proposal to create five subgroups for Cereal Grains Crop Group 15 including 15A Wheat subgroup; 15B Barley subgroup; 15C Corn subgroup; 15D Grain sorghum or millet subgroup; and 15E Rice subgroup?"

HED ChemSAC Recommendations for Proposal 3:

We agree with the IR-4 proposal with 5 subgroups (See Table 1). These subgroups will also harmonize with the established Codex groups (See Appendix I). We recommend that ChemSAC agree to amend the cereal grain crop group with the following 5 crop subgroups: Crop Subgroup 15-19A, Wheat subgroup; Crop Subgroup 15-19B, Barley subgroup; Crop Subgroup 15-19C, Corn subgroup; Crop Subgroup 15-19D, Grain sorghum or millet subgroup; and Crop Subgroup 15-19E, Rice subgroup. The corn subgroup includes field corn, sweet corn, popcorn, baby corn, and teosinte.

The following Table identifies the crop subgroups for Crop Group 15-19, specifies the representative commodities for each subgroup and lists all the commodities included in each subgroup.

Table 1. Crop Group 15-19: Subgroup Listing

Representative commodities	**Commodities**
Crop Subgroup 15-19A: Wheat subgroup	
Wheat	Amaranth, Grain; Amaranth, Purple; Cañihua; Chia; Cram-cram; Huauzontle, grain; Inca wheat; Princess-feather; Psyllium; Psyllium, blond; Quinoa; Rye; Triticale; Wheat; Wheat, Club; Wheat, Common; Wheat, Durum; Wheat, Einkorn; Wheat, Emmer; Wheat, Macha; Wheat, Oriental; Wheat, Persian; Wheat, Polish;

Representative commodities	Commodities
	Wheat, Poulard; Wheat, Shot; Wheat, Spelt; Wheat, Timopheevi; Wheat, Vavilovi; Wheat, Wild einkorn; Wheat, Wild emmer; Wheatgrass, intermediate; cultivars, varieties, and hybrids of these commodities.
Crop Subgroup 15-19B: Barley subgroup	
Barley	Barley; Buckwheat; Buckwheat, Tartary; Canarygrass, annual; Oat; Oat, Abyssinian; Oat, Common; Oat, Naked; Oat, Sand; cultivars, varieties, and hybrids of these commodities.
Crop Subgroup 15-19C: Corn subgroup	
Field corn and sweet corn	Baby corn; Corn, field; Corn, sweet; Popcorn; Teosinte; cultivars, varieties, and hybrids of these commodities.
Crop Subgroup 15-19D: Grain sorghum or millet subgroup	
Grain sorghum or Proso millet	Fonio, black; Fonio, white; Job's tears; Millet, barnyard; Millet, finger; Millet, foxtail; Millet, little; Millet, pearl; Millet, Proso; Sorghum, grain; Teff; cultivars, varieties, and hybrids of these commodities.
Crop Subgroup 15-19E: Rice subgroup	
Rice	Rice; Rice, African; Wild rice; Wild rice, Eastern; cultivars, varieties, and hybrids of these commodities.

IR-4 Proposal 4:

> "Does ChemSAC concur with the IR-4 proposal to keep the current representative commodities (wheat, field corn, sweet corn; grain sorghum and rice), with the addition of barley as a representative crop and that they will also be representative commodities for the amended crop subgroups representative commodity, the addition of proso millet as an alternate commodity to grain sorghum?"

HED ChemSAC Recommendations for Proposal 4:

The representative commodities for the revised crop group 15 are the same as the previous crop group, except for the addition of barley and proso millet. Barley has been added as a representative commodity and a new Barley Subgroup is recommended ([HYPERLINK \l "_Table_23._Revised"]). Barley is a representative crop in Canada and barley is also the representative commodity for the recently adopted Codex subgroup 020B, Barley, similar grains and pseudocereals with husks.

Codex also adopted Subgroup 020D Grain Sorghum and Millet subgroup with grain sorghum as the representative commodity ([HYPERLINK \l "_Table_22._Adopted"]). Sorghum and millet have exposed grains, while the husk of corn (maize) and sweet corn provide protection from residues. The difference between sorghum and millet commodities and corn can be greater than 5X. This is supported by Codex CXLs and US tolerances. However, grain sorghum is not grown in Canada and any production and is limited to forage and silage. Proso millet is a member of the current Cereal Grain Crop Group 15. It is now recommended to be an alternate, representative commodity for the Grain sorghum or millet crop subgroup 15-18D. It will be acceptable because Canada does not grow gain sorghum but does grow proso millet and there is sufficient production of millet in Canada with field trial requirements already established. The U.S. grows both commodities. By having the representative commodities for crop subgroup 15-18D to be grain sorghum or proso millet trade irritants with Canada will be avoided. Therefore, for the proposed revised crop US subgroup 15B, the representative commodities are expressed as Gain Sorghum or Proso Millet. The NAFTA Field Trial Regions for grain sorghum are 2, 4, 5, 6, 7, and 8; while proso millet is in field trial residue regions 5, 7, and 8. There is some overlap in regions 5, 7, and 8.

IR-4 Proposal 5:

> "Does ChemSAC concur with the initial IR-4 proposal that one new commodity definitions [40 CFR § 180.1(g)] will be needed for this amended crop group for sugarcane which will cover sweet sorghum to harmonize with Codex (See Table below)? Also, IR-4 feels the current commodity definitions are adequate, and do not need changing."

Table 2. Proposed Codex Crop Group 021 Grasses for Sugar Production and Grasses and Other Plants for Syrup Production.

TABLE ON EXAMPLE OF SELECTION OF REPRESENTATIVE COMMODITIES
(GRASS COMMODITY GROUPS)
for inclusion in the Principles and Guidance for the Selection of Representative Commodities for the Extrapolation of Maximum Residue Limits for Pesticides for Commodity Groups (CAC/GL 84-2012)

Codex Group / Subgroup	Examples of Representative Commodities	Extrapolation to the following commodities
Group 021 Grasses for sugar production and grasses and other plants for syrup production	Sugar cane or Sweet Sorghum	Sorgo or Sorghum, Sweet; Sugar cane

HED ChemSAC Recommendations for Proposal 5:

We agree with USDA IR-4 that a separate Crop Group proposed by Codex for" Grasses for sugar production and grasses and other plants for syrup production. will not be useful since it has only one commodity. The only other grass besides sugarcane grown for syrup production is sweet sorghum. Sorgo is a lookup term for sweet sorghum.

However, because of the similarity in the RAC (cane or stalks) for syrup production will be adequately covered by a new commodity definition [40 CFR § 180.1(g)] will be adequate for sugarcane to cover sweet sorghum. Crushing the stems for extraction of the syrup are the same as for sugarcane syrup production. From 50 - 60 pounds of juice should be obtained from 100 pounds of cane, whereas 50 - 55 pounds of juice are obtained form 100 pounds of clean sweet sorghum stalks. The RAC for sugarcane is the cane and the RAC for sweet sorghum is the stalk or stover (OPPTS 860.1500). The processed commodity for sugarcane is blackstrap molasses which is similar to syrup or sirup for sweet sorghum.

Specific Commodities Included in Definition	Comments
A	B
Sugarcane	Sugarcane, Sweet sorghum

There are three commodity definitions [§ 180.1 (g)] relevant to Cereal Grain crop groups 15 and 16. No additional changes to these commodity definitions are recommended.:

Current commodity definitions:

Specific Commodities Included in Definition	Comments
A	B
Sorghum, grain, grain	*Sorghum* spp. (sorghum, grain, sudangrass (seed crop), and hybrids of these grown for its seed)
Sorghum, forage, stover	*Sorghum spp.* [sorghum, forage; sorghum, stover; sudangrass, and hybrids of these grown for forage and/or stover.
Wheat	Wheat, triticale

We agree with USDA IR-4 that these current commodity definitions will not need any changes.

IR-4 Proposal 6:

> "Does ChemSAC concur with the IR-4 proposal to add additional commodities to Forage, Fodder and Straw of Cereal Grain Crop Group 16 and without the creation of any subgroups? The Crop Group 16 name should be changed to Forage, Hay, Stover and Straw group to be consistent with current terminology."

ChemSAC Recommendations for Question 6:

We recommend adding the following statement to Crop Group 16 to be consistent with the current group 16 and the livestock feedstuffs that are part of Crop Group 16. "The commodities included in Crop Group 16 are: Forage, hay, stover, and straw of all commodities included in the group cereal grains group". EPA may establish separate group tolerances on forage, hay, stover, or straw, if data on the representative commodities indicate differences in the levels of residues on forage, hay, stover, or straw. The Crop Group 16 name should be changed to Forage, Hay, Stover and Straw group to be consistent with current terminology.

The revised Crop Group 16-19 Forage, Hay, Stover, and Straw of Cereal Grains that consists of the following commodities:

1. Amaranth, Grain, *Amaranthus* spp.
2. Amaranth, Purple, *Amaranthus cruentus* L.
3. Baby corn, *Zea mays* L. subsp. *mays*
4. Barley, *Hordeum vulgare* L. subsp. *vulgare*
5. Buckwheat, *Fagopyrum esculentum* Moench
6. Buckwheat, Tartary, *Fagopyrum tataricum* (L.) Gaertn.
7. Canarygrass, annual, *Phalaris canariensis* L.
8. Cañihua, *Chenopodium pallidicaule* Aellen
9. Chia, *Salvia hispanica* L.
10. Corn, field, *Zea mays* L. subsp. *mays*
11. Corn, sweet, *Zea mays* L. subsp. *mays*
12. Cram-cram, *Cenchrus biflorus* Roxb.
13. Fonio, black, *Digitaria iburua* Stapf
14. Fonio, white, *Digitaria exilis* (Kippist) Stapf
15. Huauzontle, grain, *Chenopodium berlandieri* Moq. subsp. *nuttalliae* (Saff.) H. D Wilson & Heiser and *Chenopodium berlandier*
16. Inca wheat, *Amaranthus caudatus* L.
17. Job's tears, *Coix lacryma-jobi* L.
18. Millet, barnyard, *Echinochloa frumentacea* Link.
19. Millet, finger, *Eleusine coracana* (L.) Gaertn. subsp. *coracana*

20. Millet, foxtail, *Setaria italica* (L.) P. Beauv. subsp. *italic*
21. Millet, little, *Panicum sumatrense* Roth
22. Millet, pearl, *Pennisetum glaucum* (L.) R. Br.
23. Millet, proso, *Panicum miliaceum* L. subsp. *miliaceum*
24. Oat, *Avena spp.*
25. Oat, Abyssinian, *Avena abyssinica* Hochst. ex A. Rich.
26. Oat, common, *Avena sativa* L.
27. Oat, naked, *Avena nuda* L.
28. Oat, sand, *Avena strigosa* Schreb.
29. Popcorn, *Zea mays* L. subsp. *mays*
30. Princess-feather, *Amaranthus hypochondriacus* L.
31. Psyllium, *Plantago arenaria* Waldst. & Kit.
32. Psyllium, blond, *Plantago ovata* Forssk.
33. Quinoa, *Chenopodium quinoa* Willd. subsp. *quinoa*
34. Rice, *Oryza sativa* L.
35. Rice, African, *Oryza glaberrima* Steud.
36. Rye, *Secale cereale* L. subsp. *cereal*
37. Sorghum, grain, *Sorghum bicolor* (L.) Moench
38. Teff, *Eragrostis tef* (Zuccagni) Trotter
39. Teosinte, *Zea mays* L. subsp. *mexicana* (Schrad.) H. H. Iltis.
40. Triticale, X *Triticosecale* spp.
41. Wheat, *Triticum* spp.
42. Wheat, club, *Triticum aestivum* L. subsp. *compactum* (Host) Mackey
43. Wheat, common, *Triticum aestivum* L. subsp. *aestivum*
44. Wheat, durum, *Triticum turgidum* L. subsp. *durum* (Desf.) van Slageren
45. Wheat, einkorn, *Triticum monococcum* L. subsp. *monococcum*
46. Wheat, emmer, *Triticum turgidum* L. subsp. *dicoccon* (Schrank) Thell.
47. Wheat, macha, *Triticum aestivum* L. subsp. *macha* (Dekapr. & Menabde) Mackey
48. Wheat, oriental, *Triticum turgidum* L. subsp. *turanicum* (Jakubz.) Á. Löve & D. Löve
49. Wheat, Persian, *Triticum turgidum* L. subsp. *carthlicum* (Nevski) Á. Löve & D. Löve.
50. Wheat, Polish, *Triticum turgidum* L. subsp. *polonicum* (L.) Thell.
51. Wheat, poulard, *Triticum turgidum* L. subsp. *turgidum*
52. Wheat, shot, *Triticum aestivum* L. subsp. *sphaerococcum* (Percival) Mackey
53. Wheat, spelt, *Triticum aestivum* L. subsp. *spelta* (L.) Thell.
54. Wheat, Timopheevi, *Triticum timopheevii* (Zhuk.) Zhuk. subsp. *timopheevii*
55. Wheat, Vavilovi, *Triticum vavilovii* Jakubz.
56. Wheat, wild einkorn, *Triticum monococcum* L. subsp. *aegilopoides* (Link) Thell.
57. Wheat, wild emmer, *Triticum turgidum* L. subsp. *dicoccoides* (Körn. ex Asch. & Graebn.) Thell.
58. Wheatgrass, intermediate, *Iseilema prostratum* (L.) Andersson
59. Wild rice, *Zizania palustris* L.
60. Wild rice, Eastern, *Zizania aquatica* L.

Cultivars, varieties, and hybrids of these commodities.

These commodities are the same as those in the Cereal Grain Crop Group 15-19.

APPENDIX I: Codex Cereal Grain Group 020.

The Codex Cereal Grain Group 020 consists of six subgroups, with representative commodities of wheat, barley, rice, grain sorghum, maize (field corn), and sweet corn below. This classification was adopted by the 49th Session of CCPR.

TABLE ON EXAMPLES OF SELECTION OF REPRESENTATIVE COMMODITIES (GRASS COMMODITY GROUPS)

for inclusion in the Principles and Guidance for the Selection of Representative Commodities for the Extrapolation of Maximum Residue Limits for Pesticides for Commodity Groups (CAC/GL 84-2012)

Codex Group / Subgroup	**Examples of Representative Commodities[1]**	**Extrapolation to the following commodities**
Group 020 Cereal Grains	Wheat and Barley and Rice and Maize and Grain Sorghum and Sweet corn	Cereal grains (GC 0080): Amaranth, grain; Baby corn (immature corn); Barley; Buckwheat; Buckwheat, tartary; Canarygrass, annual; Cañihua; Chia; Corn-on-the-cob (kernels plus cob with husk removed); Cram-cam; Hungry rice; Huauzontle; Job's tears; Maize; Millet; Oats; Popcorn; Psyllium sp.; Quinoa; Rice; Rice, African; Rye; Sorghum; Sweet corn (whole kernel without cob or husk); Teff or Tef; Teosinte; Triticale; Wheat; Wild rice
Subgroup 020A, Wheat, similar grains and pseudocereals without husks	Wheat	Wheat, similar grains, and pseudocereals without husks (GC 2086): Amaranth, grain; Cañihua; Chia; Cram-cam; Huauzontle; Psyllium sp.; Quinoa; Rye; Triticale; Wheat
Subgroup 020B, Barley, similar grains, and pseudocereals with husks	Barley	Barley, similar grains, and pseudocereals with husks (GC 2087): Barley; Buckwheat; Buckwheat, tartary; Canarygrass, annual; Oats
Subgroup 020C Rice cereals	Rice	Rice Cereals (GC 2088): Rice; Rice, African; Wild rice
Subgroup 020D Grain Sorghum and Millet	Grain Sorghum	Grain Sorghum and Millet (GC 2089): Hungry rice; Job's tears; Millet; Grain Sorghum; Teff or Tef
Subgroup 020E Maize Cereals	Maize	Maize; Popcorn; Teosinte
Subgroup 020F Sweet corns	Sweet corn (Corn-on-the-cob) (kernels plus cob with husk removed)	Sweet corns (GC 2090): Baby corn; Sweet corn (Corn-on-the-cob) (kernels plus cob with husk removed); Sweet corn (whole kernel without cob or husk)

Codex Group / Subgroup	Examples of Representative Commodities[1]	Extrapolation to the following commodities
Group 021 Grasses for sugar production and grasses and other plants for syrup production	Sugar cane or Sweet Sorghum	Sorgo or Sorghum, Sweet; Sugar cane

[1] Alternative representative commodities may be selected based on documented regional/country differences in dietary consumption and/or areas of production.

DETAILED ANALYSIS OF THE USDA IR-4 PROPOSAL TO AMEND THE CEREAL GRAIN CROP GROUP 15 AND THE FORAGE, FODDER AND STRAW CROP GROUP 16:

DEFINITION OF THE CEREAL GRAIN COMMODITIES INCLUDING PSEUDOCEREALS OR PSEUDOGRAINS:

Cereal grains are generally defined as a grass grown for its small, edible seed and cereal grains as agronomic crops belonging to the grass family, *Poaceae/Gramineae*, which are utilized as staples. FAO defines cereals as annual plants, generally of the gramineous family, yielding grains used for food, feed, seed and industrial purposes, e.g., ethanol. FAO excludes legumes, such as pulses, but includes rice, canaryseed (*Poaceae/(Gramineae*)), buckwheat (*Polygonaceae*) and triticale (*Poaceae/(Gramineae*)).

The cereals are grown primarily for their mature grains, which are used as food and animal feed and can also be processed into other products including starch, sweeteners and biofuel. Processed products listed by FAO include flour, germ, bran, cake of bran, germ, oil and grits. Further processing produces such products as macaroni, bread, bulgur, pastry, starch, gluten, fermented beverages, malt, malt extract, rolled products (oats), wafers, breakfast cereals, infant food, mixes and dough, maltoses, fructose and syrup, glucose and dextrose, isoglucose and gluten feed and meal.

Most of the world's population relies on one or more of the cereal grains as a primary food material. They contain the main food essentials for the human and animal body, although they are deficient in vitamins and may be low in particular [HYPERLINK "https://www.encyclopedia.com/science-and-technology/biochemistry/biochemistry/amino-acid"

] portions of the protein. Pseudocereals frequently have a unique [HYPERLINK "https://www.encyclopedia.com/science-and-technology/biochemistry/biochemistry/amino-acid"] profile and can be used to supplement cereals for a more balanced amino acid diet. Starch, the primary constituent of cereal grains, breaks down in the digestive tract into simpler and more easily digested sugars to supply the body with its primary source of energy. While varying in oil percentage, the oil plays a significant role in total energy supply in the diet and some varieties have been selected with amounts adequate for processing and selling as vegetable oil. Cereals are rich in thiamine, riboflavin, niacin, and pantothenic acid, the cereals do not meet all the vitamin and mineral requirements for food or feed.

Pseudocereals or pseduograins, are not grasses, but have similar uses and are generally considered worldwide with cereal grains. Pseudocereals, produce dry fruit referred to as seed, nutlets, grains or achenes and are found in families such as *Amaranthaceae* (amaranth and Inca wheat), *Chenopodiaceae* (Cañihua) and *Polygoniaceae* (buckwheat). This proposal also includes the small seeded crop chia (*Lamiaceae*).

The cereal grain crop group is composed of true cereals (grass family) and pseudocereals which are the primary carbohydrate supply for the world's human population. Nearly half of the annual cereal production is used for human food. Cereals also serve as the primary food for dairy and livestock animals, poultry, and wild birds, and are the main ingredient in the production of alcohol. The primary cereals include wheat, rice, corn, sorghum, millets, oats, barley, and triticale. Wheat and rice provide nearly 50% of the world's food energy. Millet is a term that refers to small-seeded grain and has been applied to many unrelated species. The primary millet involved in world trade is proso millet, which is grown mostly in northern [HYPERLINK "https://www.encyclopedia.com/places/asia/chinese-political-geography/china"]. Foxtail millet and pearl millet, totally unrelated species, are also widely grown for grain on subsistence farms in [HYPERLINK "https://www.encyclopedia.com/places/oceans-continents-and-polar-regions/oceans-and-continents/asia"] and Africa, respectively, and three other unrelated millets: finger, brown-top, and Japanese are locally important cereals on subsistence farms throughout the world. Pseudocereals include amaranth, buckwheat, chia, psyllium, and quinoa. Cereals are members of the grass family (*Poaceae/Gramineae*) that are grown for their edible starchy seeds. A cereal is any edible components of the [HYPERLINK "https://en.wikipedia.org/wiki/Grain" \o "Grain"] (botanically, a type of [HYPERLINK "https://en.wikipedia.org/wiki/Fruit" \o "Fruit"] called a [HYPERLINK "https://en.wikipedia.org/wiki/Caryopsis" \o "Caryopsis"]) of cultivated [HYPERLINK "https://en.wikipedia.org/wiki/Poaceae" \o "Poaceae"], composed of the [HYPERLINK "https://en.wikipedia.org/wiki/Endosperm" \o "Endosperm"], [HYPERLINK "https://en.wikipedia.org/wiki/Cereal_germ" \o "Cereal germ"], and [HYPERLINK "https://en.wikipedia.org/wiki/Bran" \o "Bran"]. Edible grains from other plant families, such as [HYPERLINK "https://en.wikipedia.org/wiki/Buckwheat" \o ""] (*[HYPERLINK "https://en.wikipedia.org/wiki/Polygonaceae" \o "Polygonaceae"]*), [HYPERLINK "https://en.wikipedia.org/wiki/Quinoa" \o "Quinoa"] (*[HYPERLINK "https://en.wikipedia.org/wiki/Amaranthaceae" \o "Amaranthaceae"]*) and [HYPERLINK "https://en.wikipedia.org/wiki/Salvia_hispanica" \o "Salvia hispanica"] (*[HYPERLINK "https://en.wikipedia.org/wiki/Lamiaceae" \o "Lamiaceae"]*), are referred to as [HYPERLINK "https://en.wikipedia.org/wiki/Pseudocereal" \o "Pseudocereal"]. Pseudocereals are grown for the same purpose, but are not members of the grass family. Since they are grouped like their use rather than the biology of the plant.

Cereals are identified by alternate two-ranked leaves that are frequently formed near the ground. The leaves are composed of a sheath that encloses the stem (culm) and is split down the side opposite the blade. The stems are composed of nodes and internodes that elongate to varying degrees as the crop matures. The nodes associated with leaf blades are the most apparent and are identified as the swelling in the stems. Nodes lower on the plant have the potential to develop additional stems, which are frequently referred to as tillers. The grain is produced on a spikelet that varies significantly from corn to wheat to millet in size, shape, and appearance. Cereals and pseudocereals are essentially starchy crops. However, they may contain significant quantities of protein and oil, and it is frequently these constituents that determine suitability for a specific end use. Structurally the seeds are composed of three main parts including the endosperm, embryo, and seed coat. The endosperm is the primary starch storage portion but also contains some protein. The embryo is the oil storage portion, high in protein and minerals. The seed coat, also called pericarp or bran, consists mainly of cellulose and hemicellulose with some protein and lignin (Figure 1). Relative proportions of the three components vary among the different cereals with the embryo of "small grains" such as wheat, barley, rye, and oats make up less than 4% of the total seed, while in corn it averages 12%. The mature grain structures and the percent of the kernel are shown in Table 1. All cereal grain crops share similar morphological structures. A cross section of the kernel starting from the outside inward through a cereal grain includes the pericarp, seedcoat or testa, nucellar layer, endosperm, and embryo or germ. The purpose of these structures are as follows: (1) pericarp - forms a protective layer over the entire kernel; (2) seedcoat or testa - forms a protective layer over the embryo and endosperm and is united with the pericarp; (3) endosperm fills the interior of the grain, except for the embryo and consists of the aleurone layer, starch and gluten cells; (4) the embryo or germ consists of scutellum, coleoptile, foliage leaves, and root.

Table 1. Principal Parts and Proportions of the Mature Kernels of Different Cereal Grains (% By wt) (Schneider, B. 2000).

Cereal Grain	**Pericarp (%)[1]**	**Aleurone (%)[1]**	**Endosperm (%)**	**Germ (%)**
Wheat	9 - 10	3 - 4	83 - 86	2 - 3
Barley	3 - 8	7 - 8	82 - 88	2 - 3
Oats	25 - 41[2]	-	55 - 70	2 - 4
Rye	12 - 17[2]	-	80 - 85	2 - 4

[1] The bran layer includes the pericarp + the aleurone.
[2] For oats and rye the pericarp % includes estimates for the aleurone layer.

Figure 1: Cereal Grain Composition:

[HYPERLINK "https://www.google.com/url?sa=i&rct=j&q=&esrc=s&source=images&cd=&cad=rja&uact=8&ved=2ahUKEwjim6ThivnbAhUFtlkKHWnyB34QjRx6BAgBEAU&url=https%3A%2F%2Fwww.researchgate.net%2Ffigure%2FHistological-structure-of-wheat-grain-Adapted-from-Barron-etal-2007-showing_fig2_253234051&psig=AOvVaw26ZsCUgC19HYgmpEufpUQ3&ust=1530368924268598" \t "_blank"]

Pseudocereals are plants that produce fruits or seeds which are used and consumed as grains, though botanically pseudocereals are neither grasses nor true cereal grains. Pseudocereals are typically high in protein and other nutrients, [HYPERLINK "https://www.thespruceeats.com/what-are-ancient-grains-3378636"], and are considered [HYPERLINK "https://www.thespruceeats.com/what-are-whole-grains-3376950"]. Many so-called grains marketed as "ancient grains" are pseudocereals. Buckwheat and amaranth are two of the most widely used pseudocereals, but their production is dwarfed by the true cereals. Buckwheat is in the *Polygonaceae* family and amaranth is in the *Amaranthaceae* family. Neither has been the primary energy source for large regions, but both have played significant roles in food use. They both have a tap root rather than a fibrous root system and have two cotyledons rather than one as is true for the grasses. The root system consists of a tap root that extends downward to a considerable distance. Pseudocereals are herbaceous, erect growing annuals. Under ordinary conditions buckwheat attains a height like wheat. Amaranth is typically twice the height of wheat, but there are some dwarf varieties that grow taller than four feet. The buckwheat kernel is in the form of an achene, being a single seed enclosed in an indehiscent pericarp that fits tightly around the seed. The achene is three-angled and has the form of a pyramid with the base rounded. The hull or pericarp varies from silver gray to brown or black in color and is hard and thick, with the surface polished and shining. It separates readily from the mealy endosperm. The relatively large embryo is central, dividing the soft, white endosperm into two parts, the cotyledons being broad.

BOTANICAL ASPECTS OF THE CEREAL GRAIN GROUP 15 AND 16 COMMODITIES:

Most of the cereal grains are predominalely members the grass (*Poaceae/Graminaceae)* family. The proposed cereal grain crop group members are from 5 plant families (Table 2), and include othe non-grass commodities which are the pseudocereals represenatative of four other plant families. These plant families are members of the *Amaranthaceae* family which includes three commodities; the *Chenopodiaceae* family which includes two commodities; and the *Lamiaceae* family includes one commodity; and the *Polygonaceae* family which includes two commodities.

Table 2. Botanical Families of the Proposed Revisions to the Cereal Grain 15 and Forage, Fodder, and Straw of Cereal Grain Group 16.

Botanical Families	Commodity
Amaranthaceae	Amaranth, grain; amaranth, purple; Inca wheat
Chenopodiaceae	Cañihua; Huauzontle, grain
Lamiaceae	Chia
Poaceae/Graminaceae	Barley; Canarygrass, annual; Cram-cram; Fonio, black; Fonio, white; Field corn; Popcorn; Sweet con; Cram-cram; Fonio, black; Fonio, white; Job's tears; Millet, Barnyard, Millet, Finger; Millet, Foxtail; Millet, Little; Millet, Pearl; Millet, Proso; Oat, Abyssinian; Oat, Common; Oat, Naked; Oat, Sand; Oat; Princess-feather; Psyllium; Psyllium, blond; Quinoa; Rice; Rice, African; Rye; Sorghum, grain; Teff; Teosinte; Triticale; Wheat; Wheat, Club; Wheat, Common; Wheat, Durum; Wheat, Einkorn; Wheat, Emmer; Wheat, Macha; Wheat, Oriental; Wheat, Persian; Wheat, Polish; Wheat, Poulard; Wheat, Shot; Wheat, Timopheevi; Wheat, Wild einkorn; Wheat, Wild emmer; Wild rice; Wild rice, Eastern.
Polygonaceae	Buckwheat; Buckwheat, tartary

ORIGIN AND HISTORY OF CEREAL GRAIN GROUP 15:

(Adapted from "[HYPERLINK "https://www.encyclopedia.com/food/encyclopedias-almanacs-transcripts-and-maps/cereal-grains-and-pseudo-cereals"]" Encyclopedia of Food and Culture. . *Encyclopedia.com.* 24 May. 2018 <[HYPERLINK "http://www.encyclopedia.com/"]).

The origins of some cereals are obscure. More than one had its cultural beginning before recorded history. The development of cereal grains, probably more than any other factor, permitted the earliest tribes to change from nomadic life to full or partial agricultural subsistence. They provided more food with less effort than did any other crop. They were important for their ability to provide subsistence and security of subsistence over time. Cereals can be easily stored to provide food between harvests.

The various cereals probably developed in different parts of the world. Wheat has been a food crop for mankind since the beginning of agriculture. Carbonized grains dating to at least as early as 8,000 B.C. have been found in Iraq, and Syria, and many other findings in Eastern Mediterranean countries are nearly as old. The Middle East is probably the area of origin, and wheat apparently spread throughout Europe not later than the Stone Age. Corn is likely the only cereal native to the Americas, while wheat and barley may have been cultivated first in the [HYPERLINK "https://www.encyclopedia.com/history/asia-and-africa/ancient-history-middle-east/fertile-crescent"] area of the [HYPERLINK "https://www.encyclopedia.com/places/asia/middle-eastern-physical-geography/middle-east"]. The pseudocereal amaranth is also native to the Americas, and the earliest identification of amaranth as a grain comes from archaeological digs at a cave in Tehaucan, [HYPERLINK "https://www.encyclopedia.com/places/latin-america-and-caribbean/mexican-political-geography/puebla"], Mexico, where seeds were dated as 6,000 years ago. Aztec writings are the first recorded indication of its use and mention collection of large quantities of amaranth along with corn and beans. Although the origin of proso millet has not been ascertained, it is one of the first cultivated cereals, most likely prior to wheat. Proso millet has been known for many thousands of years in eastern Asia including China, [HYPERLINK "https://www.encyclopedia.com/places/asia/indian-political-geography/india"], and [HYPERLINK "https://www.encyclopedia.com/places/commonwealth-independent-states-and-baltic-nations/cis-and-baltic-political-geography/russia"]. Foxtail millet is widely distributed in warm and temperate areas and one of the world's oldest cultivated crops. It was mentioned in Chinese records as early as 2,700 B.C.E. Foxtail was the most important plant food in the Neolithic culture in China, and its domestication and cultivation constituted the earliest identifiable manifestation of this culture, the beginning of which has been estimated at over four thousand years ago. Buckwheat is native to temperate east Asia, where it was grown in China before 1000 C.E.

Development of mechanization for planting, harvesting, shipping, and processing of cereals during the first half of the twentieth century led to the greatest advancement in cereal production since the dawn of history. Practically all labor involved in modern cereal production involves mechanized operation. Mechanization along with improvements in weed, disease, and insect control, improved nutrient management, and variety improvements greatly increased production potential. Today, one farmer typically provides cereals that feed more than one hundred people. The average yield per unit of land of cereals has increased by more than 50% in the last 50 years. Increases in corn and rice have been more dramatic than those of the other cereals, but all have shown steady improvements. The dramatic yield improvements in corn have led to a production area increase in corn at the expense of oats, millet, rye, and barley. Especially in China, millet production has been pushed to more marginal areas with the best land being dedicated to corn and rice, with higher yield potential.

The sickle was used for cutting cereals during the [HYPERLINK "https://www.encyclopedia.com/social-sciences-and-law/anthropology-and-archaeology/human-evolution/stone-age"]. In biblical times the blades were made of bronze or iron. The sickle is still a part of harvesting in many developing countries. Typically, a person with a sickle can cut, bind, and shock an acre of grain in around 40 hours. Reapers were developed in [HYPERLINK "https://www.encyclopedia.com/places/oceans-continents-and-polar-regions/oceans-and-continents/europe"] and the [HYPERLINK "https://www.encyclopedia.com/places/united-states-and-canada/us-political-geography/united-states"], but this was quickly replaced by combines by 1950. Before then, grain had been flailed out by hand or threshed by treading out the grain under the feet of people or livestock. With a flail a man can thresh 7 or 8 bushels per day. A form of threshing machine still used in Asia and Africa consists of stone-studded planks, stone rollers, or metal disks on a shaft drawn by animals over the grain stalks that are spread on a threshing floor. Today, modern combines cut, thresh, and clean more than one hundred acres per day.

The mechanical corn picker was not developed until [HYPERLINK "https://www.encyclopedia.com/history/modern-europe/wars-and-battles/world-war-ii"] and replaced the age-old tradition of husking by hand from the standing stalk. If the stalks were being harvested for forage, some cut them by hand and placed them in shocks to cure. Today the corn picker has been replaced by the modern combine used on other small grains with only modifications of the header.

DIFFERENCES BETWEEN CEREAL GRAIN CROP GROUP 15 AND THE FORAGE, FODDER, AND STRAW OF CEREAL GRAIN GROUP 16: ([HYPERLINK "https://www.thespruceeats.com/what-is-a-pseudocereal-1664721"])

The Cereal Grain Crop Group 15 contains commodities that produce food mostly for human use such as edible grains as well as processed commodities such as milled byproduct such as flour, grits, bran, germ, and refined oil. In their natural form (as in *[HYPERLINK "https://en.wikipedia.org/wiki/Whole_grain" \o "Whole grain"]*), cereals are a rich source of [HYPERLINK "https://en.wikipedia.org/wiki/Vitamin" \o "Vitamin"], [HYPERLINK "https://en.wikipedia.org/wiki/Dietary_mineral" \o "Dietary mineral"], [HYPERLINK "https://en.wikipedia.org/wiki/Carbohydrate" \o "Carbohydrate"], [HYPERLINK "https://en.wikipedia.org/wiki/Fat" \o "Fat"], oils, and [HYPERLINK "https://en.wikipedia.org/wiki/Protein_(nutrient)" \o "Protein (nutrient)"]. When refined by the removal of the bran and germ, the remaining [HYPERLINK "https://en.wikipedia.org/wiki/Endosperm" \o "Endosperm"] is mostly [HYPERLINK "https://en.wikipedia.org/wiki/Carbohydrate" \o "Carbohydrate"]. In some [HYPERLINK "https://en.wikipedia.org/wiki/Developing_country" \o "Developing country"], grain in the form of [HYPERLINK "https://en.wikipedia.org/wiki/Rice" \o "Rice"], [HYPERLINK "https://en.wikipedia.org/wiki/Wheat" \o "Wheat"], [HYPERLINK "https://en.wikipedia.org/wiki/Millet" \o "Millet"], or [HYPERLINK "https://en.wikipedia.org/wiki/Maize" \o "Maize"] constitutes a majority of daily sustenance. In [HYPERLINK "https://en.wikipedia.org/wiki/Developed_country" \o "Developed country"], cereal consumption is moderate and varied but still substantial. While the cereals and pseudocereals are primarily known as a source of energy, they have played important roles in other ways throughout history. Cereal sprouts have long been known for their cleansing properties and are a common part of health food stores. Amaranth and buckwheat have been evaluated extensively for their vitamin E, B_1, and B_2 activity in reducing arteriosclerosis. Oats and buckwheat are recognized as cholesterol-lowering foods. The pseudocereals have a different amino acid composition than the cereals and when combined in the diet produce a much more ideal amino acid balance.

Crop Group 16 contains all the feedstuffs used as livestock feedstuffs. These include forage, stover, hay, hulls, straw, and various milled byproducts (See **Table 25).** Both cereals and pseudocereals have a long history of use as forage crops for livestock. The small grains (wheat, rye, barley, and oats) have been used extensively for hay, grazing, greenchop (fresh forage harvested and used as cattle feed), and silage. Foxtail millet, pearl millet, and some other millets are perhaps better known for their forage use than for their grain production. Corn and sorghum are utilized extensively for silage. Almost all stover of cereals and pseudocereals has potential utilization by livestock even though it requires supplementation with higher protein feeds such as alfalfa and soybeans. Prior to the soft dough stage, when the kernel is still immature and has not yet hardened, most cereals meet nutrient requirements of livestock. Cereal forages are used as supplemental feed for cow and calf operations, support major elements of the stocker cattle industry, and have potential to produce finished beef.

Corn fodder is an antiquated term since it is the entire corn plant used fresh or dried and incldes the ears. Modern harvesting methods since 1950's remove the ear at harvest and leave the whole stalk that is called stover, a popular beef and dairy cattle livestock feed. We should replace fodder with stover to update the commodity terminology.

Cereal silage is an important part of the dairy industry. Corn silage alone makes up over 40% of the value of the forage fed to dairy cows in the [HYPERLINK "https://www.encyclopedia.com/places/united-states-and-canada/us-political-geography/united-states"]. Corn silage is noted for its palatability, consistent quality, high yields, and energy content compared with alternative forages. The cost of production tends to be lower for corn silage than for most other forages, but this is partially offset by the large transportation costs of relatively wet material.

GROWTH AND DEVELOPMENT OF CEREAL GRAIN CROPS:

While each individual species has its own peculiarities, the cultivation of all cereal crops is similar. Most are [HYPERLINK "https://en.wikipedia.org/wiki/Annual_plant" \o "Annual plant"]; consequently, one planting yields one harvest. Wheat, rye, triticale, oats, barley, and spelt are the "cool-season" cereals. Most are broadcast seeded. These are hardy plants that grow well in moderate weather and cease to grow in hot weather 30 C [86 F], but this varies by species and variety. Winter varieties do not flower until springtime because they require [HYPERLINK "https://en.wikipedia.org/wiki/Vernalization" \o "Vernalization"]: exposure to low temperatures for a genetically determined length of time. Where winters are too warm for vernalization or exceed the hardiness of the crop (which varies by species and variety), farmers grow spring varieties. Spring cereals are planted in early springtime and mature later that same summer, without vernalization. Spring cereals typically require more irrigation and yield less than winter cereals. The "warm-season" cereals are tender and prefer hot weather. Barley and rye are the hardiest cereals, able to overwinter in the [HYPERLINK "https://en.wikipedia.org/wiki/Subarctic" \o "Subarctic"] and [HYPERLINK "https://en.wikipedia.org/wiki/Siberia" \o "Siberia"]. Many cool season cereals are grown in tropical regions. The warm season cereals are grown in tropical lowlands year-round and in temperate climates during the frost-free season. Rice is commonly grown in flooded fields, though some strains are grown on dryland. Other warm climate cereals, such as grain [HYPERLINK "https://en.wikipedia.org/wiki/Sorghum" \o "Sorghum"], are adapted to arid conditions.

Understanding how the cereal grain grow and develop is a key part of developing a pest control strategy for optimum leaf yield and quality and a helpful reference for analysis of residue field trials data by EPA scientists. Proper timing of pesticide applications, based on crop growth stage and pest growth cycle can improve a product's efficacy, prevent crop injury, and yield losses. Pesticide labels often use crop growth stages and codes to identify when to apply a pesticide, and State Extension pest control recommendations and spray schedules are based on these distinct growth stages. Rarely, if ever, will a grower need to apply treatments at all the key growth stages shown for a given crop. The number, distribution, and content of needed treatments will vary between the major cereal grain growing regions of the world and within any given region and are dependent on pest pressures, which reduce the yield, quality, and marketability of the grain.

Some of the internationally recognized growth stages for the cereal grains are represented by cereal grain BBCH Codes (Biologische Bundesanstalt, Bundessortenamt and Chemical industry), and are shown in Figure 2.

In biology, the BBCH-scale for these crops describes the [HYPERLINK "http://en.wikipedia.org/wiki/Phenology" \o "Phenology"] development of the crop. They are based on the principal growth stage such as leaf development, flowering, and fruit (grain), and they list a standard BBCH Code for each stage as well as a description of each code. The selected growth stages are also essential for identifying the propose timings to scout pest problems for control of these pests and for applications of pesticides as part of an integrated pest management program (IPM). These tables are useful for HED reviewers in determining application timing and stages of growth at application and harvest.

Growth Stages*:*

Growth stages have been developed for use in research and for pesticide labels. Management decisions in production are growth dependent especially for fertilizers, herbicides and fungicides. These include Zadoks scale, Feekes scale, and Haun scale (Figure 3). The scales differ in level of detail. The Feekes scale is more widely used in the US, while the Zadoks and BBCH scales are commonly used in Europe. The Feekes scale recognizes eleven major growth stages from seedling emergence to grain ripening. The Feekes scale is frequently used to identify optimum stages for pesticide applications such as fungicides, which focus on the plant development period from the start of stem elongation (Feekes stage 6) to completion of flowering (Feekes stage 10.53). The Haun scale is concerned mainly with leaf production and tiller and grain development are not described. The Zadoks (Figure 3) scale provides more detailed information during early development than the Feekes scale (Figure 4). The scale is divided into ten principal plant development stages, which are divided into secondary stages. The Zadok scale applies to any small gain ([HYPERLINK "http://corn.aronomy.wisc.edu/Crops/Wheat/L007.aspx"]). A comparison of cereal grain development stages by Zadoks, Feekes and Haun scales is shown in Table 3. Grain sorghum growth stages are listed in Figure 5.

Figure 2. BBCH Scale for Cereal Grain Crops:

The phenological growth stages and BBCH-identification keys of cereals are:

Growth stage	Code	Description
0: Germination	00	Dry seed (caryopsis)

Growth stage	Code	Description
	01	Beginning of seed imbibition
	03	Seed imbibition complete
	05	Radicle emerged from caryopsis
	06	Radicle elongated, root hairs and/or side roots visible
	07	Coleoptile emerged from caryopsis
	09	Emergence: coleoptile penetrates soil surface (cracking stage)
1: Leaf development[1], [2]	10	First leaf through coleoptile
	11	First leaf unfolded
	12	2 leaves unfolded
	13	3 leaves unfolded
	1 .	Stages continuous till
	19	9 or more leaves unfolded

Growth stage	Code	Description
2: Tillering[3]	20	No tillers
	21	Beginning of tillering: first tiller detectable
	22	2 tillers detectable
	23	3 tillers detectable
	2 .	Stages continuous till . . .
	29	End of tillering. Maximum no. of tillers detectable
3: Stem elongation	30	Beginning of stem elongation: pseudostem and tillers erect, first internode begins to elongate, top of inflorescence at least 1 references cm above tillering node
	31	First node at least 1 cm above tillering node
	32	Node 2 at least 2 cm above node 1
	33	Node 3 at least 2 cm above node 2
	3 .	Stages continuous till . . .

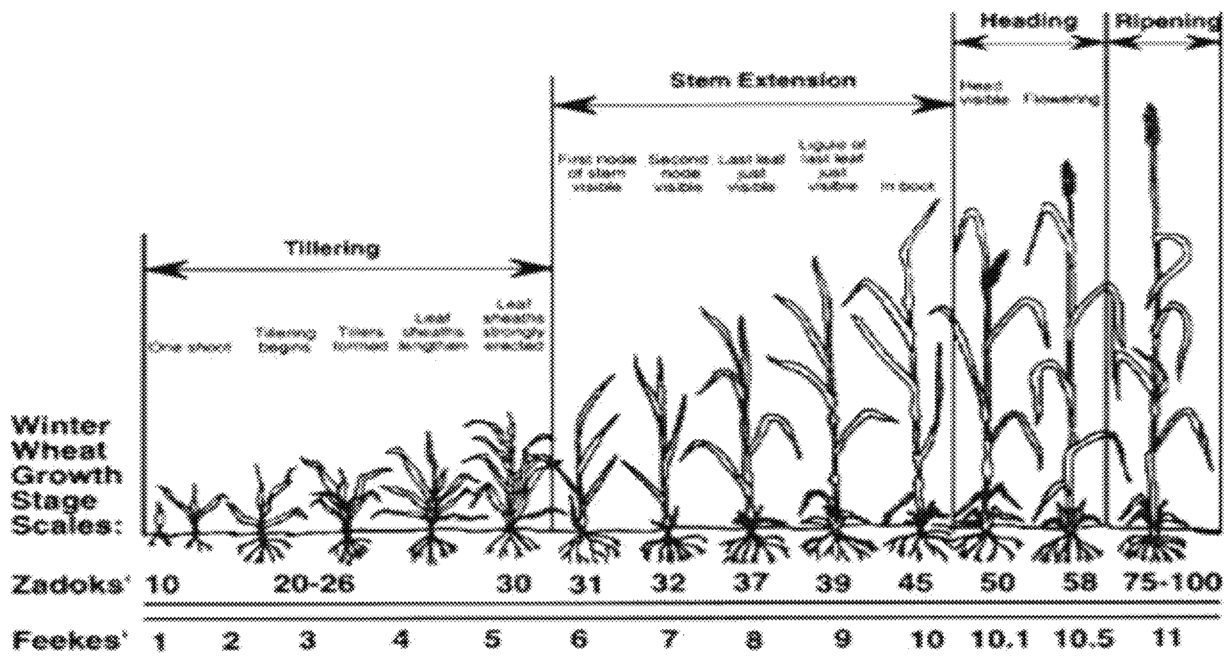
Growth stage	**Code**	**Description**
	37	Flag leaf just visible, still rolled
	39	Flag leaf stage: flag leaf fully unrolled, ligule just visible
4: Booting	41	Early boot stage: flag leaf sheath extending
	43	Mid boot stage: flag leaf sheath just visibly swollen
	45	Late boot stage: flag leaf sheath swollen
	47	Flag leaf sheath opening
	49	First awns visible (in awned forms only)
5: Inflorescence emergence, heading	51	Beginning of heading: tip of inflorescence emerged from sheath, first spikelet just visible
	52	20% of inflorescence emerged
	53	30% of inflorescence emerged
	54	40% of inflorescence emerged
	55	Middle of heading: half of inflorescence emerged

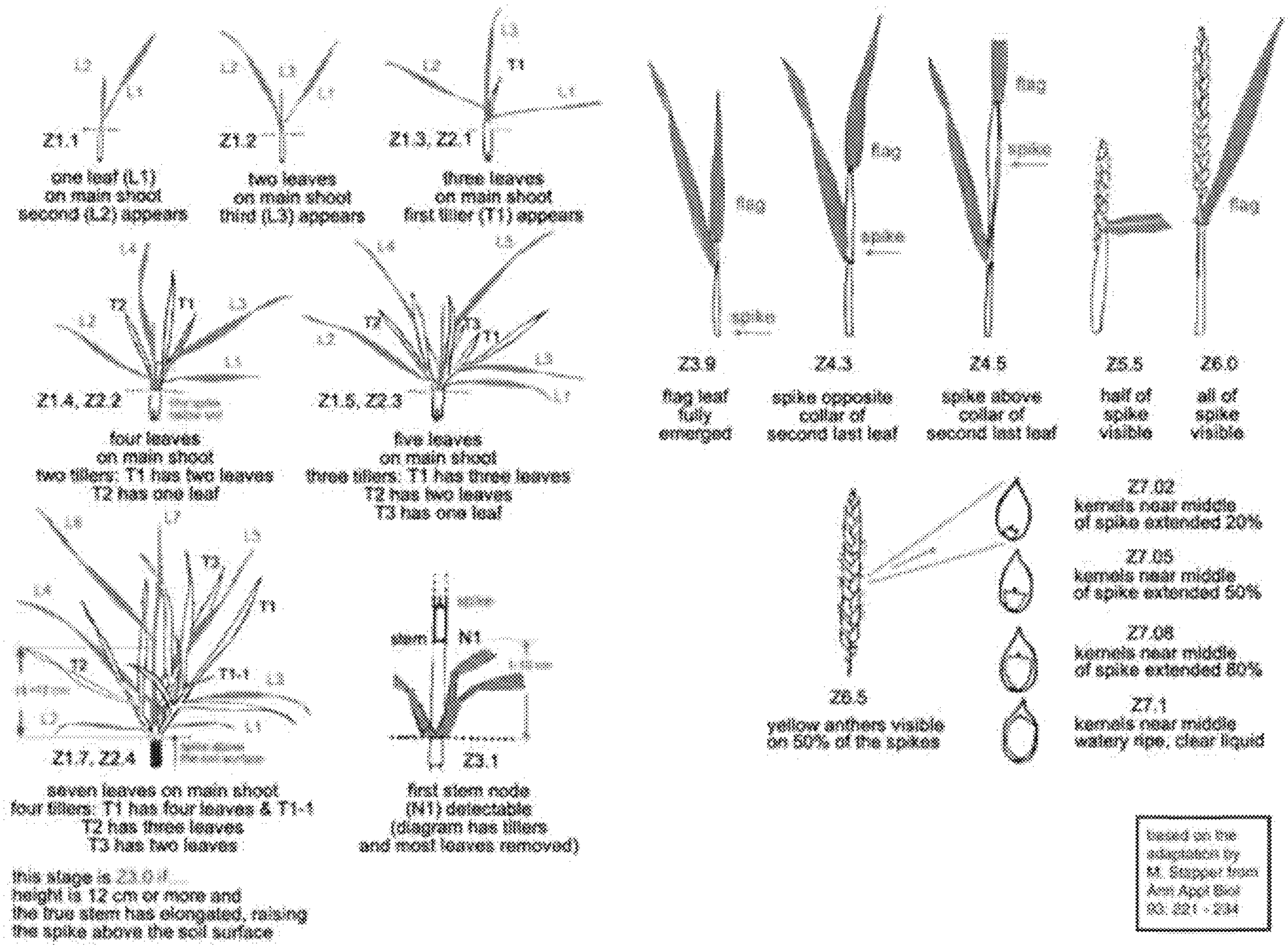
Growth stage	Code	Description
	56	60% of inflorescence emerged
	57	70% of inflorescence emerged
	58	80% of inflorescence emerged
	59	End of heading: inflorescence fully emerged
6: Flowering, anthesis	61	Beginning of flowering: first anthers visible
	65	Full flowering: 50% of anthers mature
	69	End of flowering: all spikelets have completed flowering but some dehydrated anthers may remain
7: Development of fruit	71	Watery ripe: first grains have reached half their final size
	73	Early milk
	75	Medium milk: grain content milky, grains reached final size, still green
	77	Late milk
8: Ripening	83	Early dough

Growth stage	Code	Description
	85	Soft dough: grain content soft but dry. Fingernail impression not held
	87	Hard dough: grain content solid. Fingernail impression held
	89	Fully ripe: grain hard, difficult to divide with thumbnail
9: Senescence	92	Over-ripe: grain very hard, cannot be dented by thumbnail
	93	Grains loosening in day-time
	97	Plant dead and collapsing
	99	Harvested product

[1]A leaf is unfolded when its ligule is visible or the tip of the next leaf is visible.
[2]Tillering or stem elongation may occur earlier than stage 13; in this case continue with 21.
[3]If stem elongation begins before the end of tillering continue with stage 3.0

Figure 3. Growth Stages of Cereal Grains - Zadoks' Growth Stages:





Z1.1
one leaf (L1)
on main shoot
second (L2) appears
Z1.2
two leaves
on main shoot
third (L3) appears
Z1.3, Z2.1
three leaves
on main shoot
first tiller (T1) appears
Z1.4, Z2.2
four leaves
on main shoot
two tillers: T1 has two leaves
T2 has one leaf
Z1.5, Z2.3
five leaves
on main shoot
three tillers: T1 has three leaves
T2 has two leaves
T3 has one leaf
Z1.7, Z2.4
seven leaves on main shoot
four tillers: T1 has four leaves & T1-1
T2 has three leaves
T3 has two leaves
this stage is Z3.0 if...
height is 12 cm or more and
the true stem has elongated, raising
the spike above the soil surface
stem
N1
Z3.1
first stem node
(N1) detectable
(diagram has tillers
and most leaves removed)
Z3.9
flag leaf
fully
emerged
Z4.3
spike opposite
collar of
second last leaf
Z4.5
spike above
collar of
second last leaf
Z5.5
half of
spike
visible
Z6.0
all of
spike
visible
flag
spike
Z6.5
yellow anthers visible
on 50% of the spikes
Z7.02
kernels near middle
of spike extended 20%
Z7.05
kernels near middle
of spike extended 50%
Z7.08
kernels near middle
of spike extended 80%
Z7.1
kernels near middle
watery ripe, clear liquid
based on the
adaptation by
M. Stapper from
Ann Appl Biol
93: 221 - 234

Figure 4:

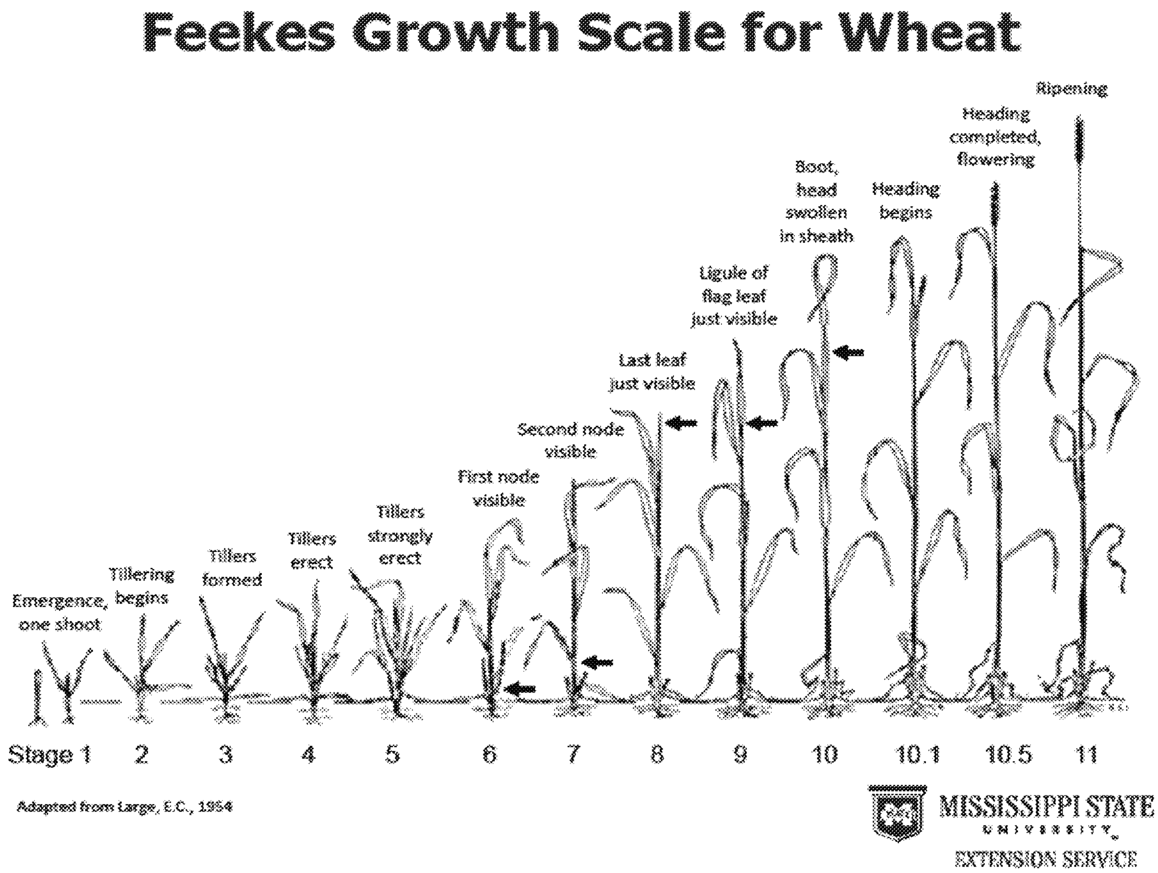


Figure 5. Grain Sorghum Growth Stages (Gerik et al. 2003).

[HTMLCONTROL Forms.HTML:Checkbox.1] [INCLUDEPICTURE "http://irf-info.com/wp-content/uploads/2015/01/Grain-Sorghum-Growth-Chart.jpg" * MERGEFORMAT]

After emergence sorghum growth stages develops in a predictable manner.

The ten major growth stages that the small grains (wheat, rye, barley, oat, rice) plant progresses through during its life cycle are all familiar to farmers and for rice see **Figure 6** below:

1. Germination
2. Seedling
3. Tillering
4. Stem elongation or Jointing

5. Booting
6. Heading
7. Flowering or Anthesis
8. Milk
9. Dough
10. Ripening

Figure 6. Rice Growth Stages.

[INCLUDEPICTURE "https://tse2.mm.bing.net/th?id=OIP.vLvfVnEGbz5Yc-Jt4NUHwgHaHo&pid=Api" * MERGEFORMAT]

Table 3. Cereal Grain Development Stages by Zadoks, Feekes and Haun Scales.

Cereal grain development stages by Zadoks, Feekes and Haun scales.			
Zadoks Scale	**Feekes Scale**	**Haun Scale**	**Description**
Germination			
00	-	-	Dry Seed
01	-	-	Start of imbibition
03	-	-	Imbibition complete
05	-	-	Radicle emerged from seed
07	-	-	Coleoptile emerged from seed
09	-	0.0	Leaf just at coleoptile tip
Seedling Growth			
10	1	-	First leaf through coleoptile
11	-	1.0	First leaf extended
12	-	1.+	Second leaf extending
13	-	2.+	Third leaf extending
14	-	3.+	Fourth leaf extending
15	-	4.+	Fifth leaf extending
16	-	5.+	Sixth leaf extending
17	-	6.+	Seventh leaf extending
18	-	7.+	Eighth leaf extending
19	-	-	Nine or more leaves extended
Tillering			
20	-	-	Main shoot only
21	2	-	Main shoot and one tiller
22	-	-	Main shoot and two tillers
23	-	-	Main shoot and three tillers
24	-	-	Main shoot and four tillers
25	-	-	Main shoot and five tillers
26	3	-	Main shoot and six tillers
27	-	-	Main shoot and seven tillers

Cereal grain development stages by Zadoks, Feekes and Haun scales.			
Zadoks Scale	**Feekes Scale**	**Haun Scale**	**Description**
28	-	-	Main shoot and eight tillers
29	-	-	Main shoot and nine tillers
Stem Elongation			
30	4-5	-	Psuedo-stem elongation
31	6	-	First node detectable
32	7	-	Second node detectable
33	-	-	Third node detectable
34	-	-	Fourth node detectable
35	-	-	Fifth node detectable
36	-	-	Sixth node detectable
37	8	-	Flag leaf just visible
39	9	-	Flag leaf ligule/collar just visible
Booting			
40	-	-	-----
41	-	8-9	Flag leaf sheath extending
45	10	9.2	Boot just swollen
47	-	-	Flag leaf sheath opening
49	-	10.1	First awns visible
Inflorescence Emergence			
50	10.1	10.2	First spikelet of inflorescence visible
53	10.2	-	1/4 of inflorescence emerged
55	10.3	10.5	1/2 of inflorescence emerged
57	10.4	10.7	3/4 of inflorescence emerged
59	10.5	11.0	Emergence of inflorescence completed
Anthesis			
60	10.51	11.4	Beginning of anthesis
65	-	11.5	Anthesis 1/2 completed
69	-	11.6	Anthesis completed
Milk Development			
70	-	-	-----
71	10.54	12.1	Kernel watery-ripe
73	-	13.0	Early milk
75	11.1	-	Medium milk
77	-	-	Late milk
Dough Development			
80	-	-	-----

Cereal grain development stages by Zadoks, Feekes and Haun scales.			
Zadoks Scale	**Feekes Scale**	**Haun Scale**	**Description**
83	-	14.0	Early dough
85	11.2	-	Soft dough
87	-	15.0	Hard dough
Ripening			
90	-	-	-----
91	11.3	-	Kernel hard (difficult to divide by thumbnail)
92	11.4	16.0	Kernel hard (can no longer be dented by thumbnail)
93	-	-	Kernel loosening in daytime
94	-	-	Overripe, straw dead and collapsing
95	-	-	Seed dormant
96	-	-	Viable seed giving 50% germination
97	-	-	Seed not dormant
98	-	-	Secondary dormancy induced
99	-	-	Secondary dormancy lost

CLIMATE AND SOILS AFFECT ADAPTION OF CEREAL GRAINS COMMODITIES TO CERTAIN REGIONS:

Climate and soils affect the regional distribution of the cereal grains (see **Table 4**).

Table 4. Climate and Soils Specific to Cereal Grains.

Crop	Climate and Soils
Amaranth, grain	Fast growing annual adapted to low to medium humidity. Found in Andean mountains, and grown at sea level. Direct combining is typical after killing frost. It can be broadcast or row seeded.
Barley	It is a highly-adaptable crop, growing north of the Arctic Circle and as far south as Ethiopia. Heavy impermeable soils and light acid soils are unsuitable for barley.
Buckwheat	Summer growing annual. Common buckwheat does not grow well on heavy wet soils or high lime soils. Light sandy soils with a high nitrogen level may cause lodging and reduction in seed yields. Common buckwheat does not grow well on heavy wet soils or high lime soils. Light sandy soils with a high nitrogen level may cause lodging and reduction in

Crop	Climate and Soils
	seed yields. Tolerates poor soil, grows well on rocky hillsides and thrives without chemical pesticides
Canarygrass, annual	Production practices and cycle like other cereal crops such as wheat and oats. Production practices and cycle like other cereal crops such as wheat and oats.
Cañihua	Resists strong winds and heavy rains.
Chia	Biannually cultivated, chia is a low-maintenance crop that prefers moderately fertile, well-drained soils. While moisture is necessary for seedling establishment, this crop is highly intolerant of wet soils. Seeds are planted into a fully tilled seed bed using a standard grain drill or planter with small seed metering capability; some adjustments to this equipment may be necessary. Because of the small seed size, precision planting is important to ensure good seed-to-soil contact.
Corn	Corn is an annual crop. Hot, dry winds may reduce the amount of pollen available for fertilization and humid conditions and hail can do damage. Since the crop leaves much of the ground uncovered, soil erosion and water losses can be severe. It is probably indigenous to Mexico and Central America.
Cram-cram	It is extremely abundant in the Sahel and southern Sahara, where it may form massive stands.
Fonio	This annual crop is planted during June and July, and harvested in September and October.
Huauzontle, grain	Huauzontle is an annual plant. It requires moist soil to grow and can grow well in sandy, loamy and clay soils. The soil may be acidic, alkaline or neutral. The seeds germinate very quickly. They need proper sunlight as they are unable to grow well in shady conditions. In temperate zones, it is best to start huauzontle in a greenhouse and transplant out into the field after the danger of frost.
Job's tears	Job's tears need reasonably high rainfall in areas which grow maize and upland rice, usually in excess of 1,500 mm. It is not tolerant of drought. It requires a fertile soil for its best growth. In poor soils, many of the fruits are hollow. It spreads very slowly in favorable environments.
Miller, finger	Finger millet is normally grown at altitudes from sea level up to 2500 m. In East Africa, it is usually grown at altitudes between 1,000 - 2,000 m and in India and Ethiopia some varieties are grown above

Crop	Climate and Soils
	2500 m. It is common on roadsides and banks, naturalized from cultivation.
Millet, foxtail	It is generally grown in the 500 - 700 mm rainfall areas. Foxtail millets require less rainfall than sorghum and corn but success depends on rain. It is tolerant of drought; it can escape some droughts because of early maturity. Prefers sandy loams to clay loams.
Millet, pearl	Summer annual pasture grass or grown for greenchop and hay.
Millet, proso	Best adapted to areas of low or medium relative air humidity. It generally grows in areas receiving a rainfall within the range of 500 - 750 mm with a summer dominance. Survives hot weather better than other millets. It prefers sandy loams to clay loams, but has a wide soil range. Germination difficulties may be encountered in heavy, self-mulching clays. It needs full sunlight for growth.
Oat	Oats may be grown in mixture with annual, twining legumes such as peas and vetches but it is essential that the growth cycles of the two crops match, otherwise the legume will have dried and shattered before the oats are at the cutting stage. Time of sowing varies widely depending upon the wide range of climates where oats are grown. In areas of very cold winters they are spring sown; in temperate climates both autumn and spring sowing occurs.
Psyllium	Grows best on light, well drained, sandy loams. The nutrient requirements of the crop are low. *P. ovata* is a 119 – 130-day crop that responds well to cool, dry weather. A very important environmental requirement of this crop is clear, sunny and dry weather preceding harvest. High night temperature and cloudy wet weather close to harvest have a large negative impact on yield. Rainfall on the mature crop may result in shattering and therefore major field losses.
Quinoa	Annual, with a growth period of 90 - 220 days. Unaffected by -1°C, and some types withstand lower temperatures. The cultivated plants show great variability, five ecotype categories are recognized: Valley; (2000 - 3600 m, and long growing period), Altiplano; (frost hardy with short growing period),

Crop	Climate and Soils
	Salar; (hardy and salt tolerant), Sea level; (long-day plant), and subtropical type.
Rice	Around the world, rice thrives in warm, humid climates; almost all the U.S. rice crop is grown in Arkansas, California, Louisiana, Mississippi, Missouri and Texas.
Rye	Rye is widely grown in areas with cold winters and warm, dry summers. Autumn sown cultivars require exposure to low temperatures as a prerequisite to flowering before they can respond to long days in the spring. Grown at high altitudes up to 4,300 m in the Himalayas. Photosynthesis pathway C3. In Scandinavia, it can be grown within the Arctic Circle. It is widely grown in areas with cold winters and warm, dry summers.
Sorghum, grain	Sorghum thrives where other crops would wither and die; in drought periods, in fact, it becomes partially dormant.
Teff	Teff can grow where many other crops will not thrive, and in fact can be produced from sea level to as high as 3,000 m of altitude, with maximum yield at about 1,800 - 2,100 m high. This versatility could explain why teff is now being cultivated in areas as diverse as dry and mountainous Idaho and the low and wet Netherlands.
Triticale	Grows easily without commercial fertilizers and pesticides, making it ideal for organic and sustainable farming. Preparation of the seedbed should be like that for oat, barley or wheat. Spring triticale varieties, as other small grains, should be planted as early as practical. Winter varieties should be planted in the fall on dates like winter wheat but even more care should be taken to leave surface residue to catch snow. Phosphorus must be adequate for good yields and triticale uses more nitrogen than wheat.
Wheat	Wheat is grown in a range of environments, from relatively limited water availability to high water availability. In addition, wheat can withstand a wide temperature range, and is thus widely produced in the temperate regions both in the winter and spring. Wheat is also commonly grown in warmer regions; however, higher temperatures during flowering and grain filling can significantly depress wheat yield.

Crop	Climate and Soils
Wheatgrass, intermediate	This is a perennial cool season sod-forming wheatgrass, introduced from Eurasia. It is adapted to areas with rainfall > 350 mm and elevations up to 3000 m. It reproduces by seed, tiller and rhizomes.
Wild rice	Wild rice can be grown either in natural or cultivated stands.

COMPARISON OF CEREAL GRAIN GROWING SEASON AND HARVESTING:

The growing season and harvesting timing for the cereal grains are discussed in Table 5.

Table 5. Cereal Grains Growing Season and Harvesting.

Crop	Growing Season and Harvesting
Amaranth, Grain	About 4 - 6 months. Direct combining is typical after killing frost. It can be broadcast or row seeded. Fast growing annual adapted to low to medium humidity. ature seeds in 120 - 180 days; highland regions may require 300 days.
Barley	Annual grass, can be harvested after 90 - 120 days for spring varieties, and after 180 - 240 days for winter varieties.
Buckwheat	In cool areas 55 - 85 days is sufficient to mature a seed crop.
Canarygrass, Annual	Cool season, spring growth through early summer. There are 63 - 66 days from planting to heading. About 100 days from seeding to harvest for grain.
Cañihua	Flowers from July to October and seeds ripen from August to October. Annual reaching maturity in 95 - 150 days. Must be harvested before it matures fully, otherwise the seeds scatter on the ground. In the Andes, it can be found at elevations from 1500 - 4400 m, but rarely cultivated below 3,800 m
Chia	Chia is planted in April or May and harvested in October in Kentucky. Chia is harvested early enough that it may be possible to double-crop chia with winter wheat.
Corn	Most require 100 - 140 days and some as little as 80 days for field corn. Sweet corn 2½ to 4 months. Popcorn is 90 to greater than 110 days. Baby corn 60 days. In the United States on average it matures in 90-140 days. In Kenya, quick-maturing lowland varieties flower in 60 days and mature in 120 days, varieties grown between 1,200 - 2,100 m in elevation flowers in 105 days and mature in 210 days, while varieties grown at 2,100 - 3,200 m may take 195 days to flower and more than 365 days to mature. In the United States on average it matures in 90 - 140 days. It can be found at elevations

Crop	Growing Season and Harvesting
	between sea level and 4,000 m and it can be grown at latitudes from 48°N to 40°S.
Cram-cram	Mostly found in semi-arid and arid regions with an annual rainfall of 250 – 650 mm, up to 1300 m altitude, usually on dry sandy soils and in cultivated, overgrazed or otherwise disturbed areas.
Fonio	The crop is sown during June and July, and harvested in September and October. It is an annual. Reaches maturity in 90 - 130 days depending on cultivar.
Huauzontle, grain	The plant flowers from July to October. The ripening of the seeds starts from August and continues till October. The flowers are pollinated by wind. The seeds are small and it is relatively easy to harvest them. The plants can be harvested within 7 to 8 weeks.
Job's tears	It is sown at the beginning of the wet season and flowers from July to October. The seeds ripen from September to November.
Millet, finger	Annual. Short duration varieties require 75 - 100 days to harvest, medium duration 105 - 110 days, and long duration 120 - 180 days.
Millet, foxtail	Seeded in late spring, 60 - 70 days to harvest. Cut for hay at late boot to late bloom stage.
Millet, pearl	Early millets, requires 60 - 95 days of growing period, medium duration types, about 80 days, and long duration types, 100 - 120 days.
Millet, proso	Seeding to harvest: 50 - 75 days. Yields range 2,500 - 2,800 lb/A in Minnesota.
Oat	Seeding to harvest: About 85 - 100 days.
Psyllium	Seeding to harvest: About 107-130 days. Plants flower 60 days after planting.
Quinoa	Seeding to harvest: 80 - 190 days.
Rice	About 110 - 130 days for early varieties and 160 - 195 for late varieties.
Rye	Annual grass, grain crop, that provides groundcover in 45 - 60 days, flowers after 70 - 90 days and mature in 110 - 130 days if spring sown and in 210 - 270 days if autumn planted.
Sorghum, grain	Days to flowering vary from 62 – 90. Seeding to harvest varies from 95 - 120 days or more.
Teff	Summer annual, require 65 - 90 days for hay crop and 90 -150 days for grain crop.
Triticale	Seeding to harvest ranges 100 - 120 days.
Wheat	Seeding to harvest varies 90 - 260 days depending on variety and time of planting. Harvesting of winter wheat may begin before June 1 in SE U.S. and late summer in Montana. Harvesting of spring wheat begins mid-July in Midwest and Pacific Northwest, while

Crop	Growing Season and Harvesting
	beginning after 1 August in northern states.
Wheatgrass, intermediate	This is a perennial cool season sod-forming wheatgrass, introduced from Eurasia. It has proved well adapted to the Northern and Central Great Plains, and in the Pacific Northwest, as well as Canada. It is adapted to areas with rainfall > 350 mm and elevations up to 3000 m. For both pasture and hay production, this is a valuable grass for its area of adaptation, as well as good for soil erosion control.
Wild rice	Commercial crop has a similar culture to rice. About 106 - 130 days to mature after seeding. Seed in fall in Minnesota and in the spring in California.

US/NAFTA AND WORLD PRODUCTION AND GEOGRAPHICAL DISTRIBUTION OF CEREAL GRAIN COMMODITIES (See Appendix 3, Table 2):

NAFTA Production.

The proposed members of the Cereal Grain Crop Group are widely produced throughout the world (See Appendix3. ProductionTable 2. NAFTA and World Cereal Grain Production (FAOSTAT). The table lists the harvested acres of the proposed cereal grain crops from various countries of the nernational Crop Group Consulting Committee (ICGCC) as well as other cereal grain producing countries. Field corn is the hghest procduced cereal grain in NAFTA in 2014 with the US at 83,136,000 harvested acres followed by Mexico at 17,445,940 harvested acres and Canada at 3,030,329 harvested acres. Wheat is the second cereal grain with the most harvested acres in NAFTA in 2014 with the US at 46,385,000 harvested acres followed by Canada at 23,380,355 harvested acres and Mexico at 1,746,036 harvested acres. Wild rice harvested acres were not reported for Canada or Mexico. And it is not grown in Canada

EXPORTS/IMPORTS OF THE CEREAL GRAIN COMMODITIES:

Table 6 includes all wheat, hard red winter wheat, hard red spring wheat, soft red winter wheat, hard white wheat, soft white wheat and Durum wheat by selected destinations exported from 2008 to 2014. [HYPERLINK \l "_Table_12._US"] includes malting barley, other barley and oats exports by selected destination from 2009 to 2016. [HYPERLINK \l "_Table_12._US_1"] includes corn exports by selected destinations from 2009 to 2016. [HYPERLINK \l "_Table_13._US"] includes white corn exports by selected destinations from 2007 to 2015. [HYPERLINK \l "_Table_15._US"] includes sorghum exports by selected destination from 2009 to 2016. The main exports of wheat is to Brazil, Mainland China, Mexico, Japan, and Nigeria. The main exported types os U.S. wheat are hard red winter and soft red whea. Most corn is exported to Mexico and Japan (Table 8).

Although the U.S. is a major producer of cereal grains, significant amounts of cereal grains and products such as bulk grains, wheat and products, rice and products, milled grain products, and cereal and bakery foods ([HYPERLINK \l "_Table_9._US"]) are imported. Most total grains, bulk grains, wheat and products, milled grain products and cereal and bakery goods are imported from Canada. Significant amount of rice is imported from Thailand and India ([HYPERLINK \l "_Table_10._US"]10).

Table 6. US Wheat Exports by Class for Selected Destinations

U.S. wheat exports by class for selected destinations (1,000 bushels)							
Class and country/region [1]		2008/09	2009/10	2010/11	2011/12	2012/13	2013/14
All wheat	Brazil	28,706	10,514	14,843	4,124	17,209	158,555
	China, Mainland	5,418	13,885	4,560	20,672	27,339	152,460
	Mexico	90,719	72,138	105,395	144,471	112,506	113,621
	Japan	115,393	117,023	121,623	129,592	127,877	103,671
	Nigeria	97,974	123,369	134,495	121,817	106,477	99,074
	Philippines	52,760	58,770	64,401	75,635	69,713	74,919
	Korea, Republic	40,732	41,107	60,436	79,738	50,536	48,044
	Indonesia	27,067	20,748	28,972	32,965	19,042	41,745
	China, Taiwan	26,350	31,092	33,884	33,001	38,214	38,111
	Colombia	27,601	23,718	28,123	18,105	22,221	28,776
	Italy	15,526	15,264	30,010	14,666	16,893	26,722
	Thailand	16,073	17,160	18,456	18,454	21,004	23,684
	Venezuela	22,102	24,450	23,429	22,127	23,312	22,653
	Peru	12,754	20,361	36,242	21,239	21,184	20,175
	Dominican Republic	14,772	15,228	19,989	20,016	17,877	19,236
	Chile	15,790	14,396	13,871	13,571	19,078	18,789
	El Salvador	13,935	21,761	9,898	861	912	15,351
	Yemen	17,729	19,366	24,275	15,339	17,755	14,887
	Guatemala	8,080	4,510	17,213	22,391	26,805	12,604
	Egypt	66,206	16,743	146,274	34,839	63,793	9,676
	Total – All Countries	984,392	848,617	1,264,973	1,034,628	--	--

Table 6. US Wheat Exports by Class for Selected Destinations (continued)

U.S. wheat exports by class for selected destinations (1,000 bushels)							
Class and country/region [1]		2008/09	2009/10	2010/11	2011/12	2012/13	2013/14
Hard red winter	Brazil	19,407	5,633	13,888	--	13,351	149,378
	Nigeria	77,075	95,293	105,471	96,074	85,947	74,736
	Mexico	50,360	40,992	64,580	69,848	64,574	53,546
	Japan	31,230	35,574	30,451	35,513	35,256	33,005
	Colombia	16,421	10,981	10,740	7,486	14,329	16,083
	Peru	8,233	17,072	32,457	17,182	16,846	13,338
	Venezuela	8,426	10,051	10,190	9,228	10,832	9,799

U.S. wheat exports by class for selected destinations (1,000 bushels)							
Class and country/region [1]		2008/09	2009/10	2010/11	2011/12	2012/13	2013/14
	China, Taiwan	6,936	11,380	4,234	8,976	11,855	9,734
	Korea, Republic	9,392	9,008	11,558	8,807	10,227	7,692
	Dominican Republic	5,389	5,035	7,982	9,147	7,437	7,426
	Chile	6,060	7,440	8,283	5,012	8,037	7,423
	Guatemala	2,667	1,734	8,397	9,597	13,630	6,508
	El Salvador	9,117	10,245	3,933	649	180	6,194
	Ethiopia	5,463	28,840	7,624	10,426	10,215	5,901
	Israel	13,544	6,449	16,181	9,815	8,480	5,825
	Indonesia	10,692	5,058	10,832	4,965	3,068	4,350
	Thailand	2,991	3,966	4,068	4,252	3,679	4,313
	Honduras	2,871	3,214	2,960	1,936	2,564	2,744
	Ecuador	1,950	1,581	1,353	874	1,222	2,598
	Haiti	6,280	3,534	--	3,099	6,379	2,585
	Total	438,688	353,677	614,416	393,761	--	--

Table 6. US Wheat Exports by Class for Selected Destinations (continued)

U.S. wheat exports by class for selected destinations (1,000 bushels)							
Class and country/region [1]		2008/09	2009/10	2010/11	2011/12	2012/13	2013/14
Hard red spring	Philippines	28,631	29,155	34,256	43,616	39,458	43,166
	Japan	55,494	52,465	59,877	51,275	48,808	39,058
	China, Taiwan	15,603	15,392	25,487	19,026	21,615	21,343
	Indonesia	4,725	1,354	8,042	17,114	5,122	20,135
	China, Mainland	10	4,246	2,122	13,010	17,460	16,978
	Korea, Republic	11,735	10,554	16,349	14,512	14,218	13,627
	Thailand	7,267	7,867	8,647	7,928	11,121	11,741
	Venezuela	8,356	8,442	9,145	10,725	9,653	10,507
	Italy	5,176	2,628	12,731	4,502	7,016	9,569
	Mexico	8,950	6,523	14,917	7,059	5,946	8,620
	Dominican Republic	5,903	6,367	7,601	6,372	6,001	6,899
	Malaysia	1,897	2,732	5,404	5,612	2,259	4,575
	Nigeria	2,024	5,966	4,923	3,173	408	4,379
	Jamaica	1,909	3,200	3,689	3,266	3,778	3,488
	El Salvador	3,043	6,625	3,407	66	272	3,433
	Honduras	2,010	1,922	2,413	1,735	2,903	3,409
	Brazil	--	--	--	--	--	3,182
	United Kingdom	1,679	1,303	2,069	2,594	1,913	3,156
	Guatemala	1,438	949	3,860	5,621	5,365	3,026
	Vietnam	326	115	7,247	2,418	3,688	2,882
	Total	201,833	202,645	322,273	242,427	--	--

Table 6. US Wheat Exports by Class for Selected Destinations (continued)

U.S. wheat exports by class for selected destinations (1,000 bushels)							
Class and country/region [1]		2008/09	2009/10	2010/11	2011/12	2012/13	2013/14
Soft red winter	China, Mainland	5,404	7,689	138	3,739	5,435	128,970
	Mexico	31,333	24,623	22,838	50,123	41,906	50,169
	Nigeria	14,044	13,625	16,297	16,047	13,973	17,992
	Colombia	8,417	7,898	6,619	8,069	7,408	9,764
	Egypt	65,544	15,567	28,264	26,212	41,441	9,676
	Brazil	9,299	4,881	955	4,124	3,858	5,995
	Ecuador	3,057	2,146	2,740	1,814	5,165	5,966
	Peru	4,521	3,024	3,546	4,057	4,338	4,981
	Dominican Republic	3,480	3,708	4,085	4,497	4,439	4,911
	Chile	9,487	1,046	--	1,582	4,384	4,076
	Honduras	2,306	1,996	1,786	2,381	2,840	3,248
	Jamaica	3,410	3,307	3,123	3,132	3,299	3,227

U.S. wheat exports by class for selected destinations (1,000 bushels)							
Class and country/region [1]		2008/09	2009/10	2010/11	2011/12	2012/13	2013/14
	Rep. of South Africa	2,194	2,265	960	1,733	1,694	2,549
	Costa Rica	2,062	1,970	1,760	2,260	2,607	2,358
	China, Taiwan	413	51	21	173	--	2,134
	Japan	1,057	55	--	--	5,851	1,938
	El Salvador	784	166	55	146	460	1,731
	Trinidad	1,048	1,133	1,126	1,198	1,289	1,616
	Panama	1,873	1,318	1,130	2,860	2,010	1,233
	United Arab Emirates	1,205	117	724	1,091	808	849
	Total	188,120	105,624	103,959	159,705	--	--

Table 6. US Wheat Exports by Class for Selected Destinations (continued)

U.S. wheat exports by class for selected destinations (1,000 bushels)							
Class and country/region [1]		2008/09	2009/10	2010/11	2011/12	2012/13	2013/14
Hard white	Nigeria	1,846	4,394	4,221	4,612	3,608	446
	Colombia	--	--	--	--	--	220
	Belgium	--	--	--	--	--	--
	China, Mainland	--	--	--	--	--	--
	China, Taiwan	337	62	95	83	18	--
	Ecuador	--	--	--	--	--	--
	Egypt	--	--	--	--	--	--
	Indonesia	--	--	--	--	--	--
	Israel	--	--	--	--	--	--
	Korea, Republic	--	--	73	--	--	--
	Lebanon	--	--	--	--	--	--
	Malaysia	--	--	698	387	20	--
	Mexico	20	--	48	--	40	--
	Morocco	--	--	--	--	--	--
	Peru	--	--	--	--	--	--
	Philippines	--	--	46	3	--	--
	Rep. of South Africa	--	--	--	--	--	--
	Thailand	--	--	--	--	--	--
	United Kingdom	--	--	--	--	--	--
	Uruguay	--	--	--	1	--	--
	Total	2,352	4,820	5,184	5,086	--	--

Table 6. US Wheat Exports by Class for Selected Destinations (continued)

U.S. wheat exports by class for selected destinations (1,000 bushels)							
Class and country/region [1]		2008/09	2009/10	2010/11	2011/12	2012/13	2013/14
Soft white	Philippines	22,337	28,463	29,490	30,184	29,270	30,414
	Japan	27,600	28,914	31,171	40,928	37,955	29,670
	Korea, Republic	19,377	21,253	30,089	43,735	25,844	26,460
	Indonesia	10,111	13,971	10,098	10,886	10,852	17,259
	Yemen	15,704	19,182	18,388	15,339	16,409	14,322
	Thailand	5,674	5,211	5,734	6,274	6,204	7,630
	China, Mainland	--	1,860	2,228	3,872	4,360	6,273
	Sri Lanka	4,920	1,943	4,229	2,202	1,568	5,902
	Chile	--	4,591	4,569	6,257	6,135	5,036
	China, Taiwan	3,061	4,207	3,990	4,743	4,726	4,899
	El Salvador	991	4,635	2,503	--	--	3,790
	Afghanistan	3,823	1,390	356	937	1,225	2,313
	Vietnam	434	737	936	1,247	2,119	2,137
	Guatemala	937	755	4,088	6,190	6,314	1,750
	Malaysia	700	721	1,869	1,175	1,266	1,641
	Singapore	1,261	1,545	2,222	1,497	1,319	1,291
	Mexico	--	--	3,012	17,441	40	1,287
	Bangladesh	3,000	--	4,357	3,465	2,297	1,174
	Colombia	--	485	821	569	--	808
	Burma	--	--	43	72	439	340
	Total	134,461	144,875	180,349	200,707	--	--

Table 6. US Wheat Exports by Class for Selected Destinations (continued)

U.S. wheat exports by class for selected destinations (1,000 bushels)							
Class and country/region [1]		2008/09	2009/10	2010/11	2011/12	2012/13	2013/14
Durum	Italy	10,350	12,636	14,267	9,172	8,279	17,153
	Algeria	2,091	9,114	3,801	2,724	5,859	3,330
	Venezuela	928	1,998	3,484	1,386	1,532	1,862
	Nigeria	2,985	3,744	3,583	1,911	2,541	1,521
	Netherlands	--	826	324	234	--	709
	Guatemala	--	185	353	523	566	495
	Chile	--	--	--	--	257	305
	Belgium	--	794	1,287	464	1,802	301
	Panama	240	226	217	225	242	225
	El Salvador	--	90	--	--	--	204
	Costa Rica	565	799	657	135	--	60
	Ghana	--	--	--	--	--	4
	Botswana	--	--	--	--	--	--
	China, Taiwan	--	--	57	--	--	--

U.S. wheat exports by class for selected destinations (1,000 bushels)							
Class and country/region [1]		2008/09	2009/10	2010/11	2011/12	2012/13	2013/14
	Colombia	98	--	117	--	--	--
	Cuba	--	579	196	--	--	--
	Cyprus	--	--	--	--	--	--
	Dominican Republic	--	118	321	--	--	--
	Ecuador	--	--	--	--	--	--
	Egypt	--	--	--	--	--	--
	Total	17,935	36,976	36,686	18,049	--	--
[1] Based on inspection data. Market year is June-May. Source: USDA, Agricultural Marketing Service, Grain and Feed Market News. *Date run: 9/13/2016*							

Table 7. US Barley and Oats Exports for Selected Destinations

US barley and oats exports by selected destinations (1,000 metric tons)								
Class and country/region [1]		2009/10	2010/11	2011/12	2012/13	2013/14	2014/15	2015/16
Malting Barley [2]	Mexico	37	33	55	31	93	99	140
	Canada	36	33	25	8	5	52	52
	Japan	--	--	0	--	--	--	1
	Turks and Caicos Islands	0	--	--	--	--	--	0
	Other	0	0	50	13	3	1	0
	Total [3]	73	66	130	53	101	151	193
Other Barley [4]	Morocco	--	12	25			27	14
	Taiwan	2	7	5	5	11	32	7
	Pakistan	--	--	--	--	--	--	6
	Japan	28	11	2	70	169	90	5
	Other	20	69	31	65	30	11	12
	Total [3]	50	99	62	140	210	160	43
Oats	Canada	14	25	14	11	12	15	11
	Mexico	5	3	11	4	2	1	5
	Japan	2	3	2	2	2	3	3
	Taiwan	6	3	3	0	2	1	2
	Other	6	8	4	2	5	6	7
	Total [3]	31	41	35	20	23	27	29
[1] Market year is June-May; units are 1,000 metric tons.								
[2] Grain for malting								
[3] May not add due to rounding								
[4] Grain for purposes other than malting, such as feed and seed use.								
Source: US Department of Commerce, Bureau of the Census, Foreign Trade Statistics								

Table 8. US Corn Exports by Selection Destinations

U.S. corn exports by selected destinations (1,000 metric tons)								
Export and country/region [1]		2009/10	2010/11	2011/12	2012/13	2013/14	2014/15	2015/16
Corn [2]	Mexico	8,253	7,483	10,097	4,581	10,490	11,333	13,337
	Japan	15,128	13,914	11,518	6,865	11,939	12,003	10,392
	Colombia	1,019	506	274	155	3,562	4,371	4,548
	South Korea	7,076	6,123	3,564	451	4,961	3,934	2,964
	Peru	885	66	0	0	1,246	2,555	2,383
	China (Taiwan)	3,181	2,737	1,553	530	1,781	1,839	2,049
	Saudi Arabia	755	576	362	346	1,031	1,185	1,389
	Venezuela	1,106	856	1,336	1,070	1,128	710	1,155
	Canada	2,098	958	870	468	479	1,490	1,006
	Guatemala	661	687	591	220	752	852	883
	Egypt	2,774	3,405	495	0	2,710	1,235	852
	Algeria	91				76	239	663
	El Salvador	441	491	381	142	409	538	654
	Costa Rica	579	712	576	122	593	774	552
	Honduras	347	443	359	206	375	428	550
	Morocco	457	182	59	0	202	298	450
	European Union-27	70	998	9	20	1,204	361	417
	Panama	327	263	209	130	333	450	392
	Israel	177	804	57	0	469	26	388
	Chile	28	1	2	1	50	75	353
	Vietnam	28	13	2	1	509	11	344
	China (Mainland)	1,199	980	5,146	2,390	2,732	747	321
	Jamaica	234	283	253	243	283	282	283
	Nicaragua	116	156	124	38	121	191	258
	Dominican Republic	930	756	363	59	596	607	253
	Other	2,311	3,115	899	505	759	886	1,368
	Total [3]	50,270	46,508	39,096	18,545	48,790	47,421	48,202

[1] Market year is September-August.
[2] Grain only.
[3] May not add due to rounding.

Source: U.S. Department of Commerce, Bureau of the Census, Foreign Trade Statistics.
Date run: 10/14/2016

Table 8. US White Corn Exports by Selection Destinations

U.S. white corn exports by selected destinations (1,000 metric tons)								
Country/region [1]	**2007/08**	**2008/09**	**2009/10**	**2010/11**	**2011/12**	**2012/13**	**2013/14**	**2014/15**
Mexico	429.02	167.73	489.31	580.95	437.18	88.40	378.14	743.00
Colombia	60.39	187.56	110.32	86.29	64.21	67.52	178.52	252.00
New Zealand	--	--	--	--	--	--	26.76	130.00
El Salvador	105.16	60.86	52.94	82.24	115.17	21.87	41.42	72.00
Guatemala	9.57	40.47	37.68	52.42	35.69	11.00		46.00
All other countries	309.93	373.59	190.23	204.48	144.15	109.25	222.97	134.00
Total [2]	914.07	830.18	880.46	1,006.23	796.40	298.03	847.80	1,377.00

[1] Based on inspection data. Market year is September-August.
[2] May not add due to rounding.

Source: USDA, Agricultural Marketing Service, Grain and Feed Market News.

Date run: 10/14/2016

Table 9. US Sorghum Exports by Selection Destinations

U.S. sorghum exports by selected destinations (1,000 metric tons)								
Export and country/region [1]		**2009/10**	**2010/11**	**2011/12**	**2012/13**	**2013/14**	**2014/15**	2015/16
Sorghum [2]	China (Mainland)	0	0		3	4,260	8,328	7,008
	Mexico	2,527	2,383	1,168	1,448	251	21	625
	Sub-Saharan Africa	634	252	335	184	444	486	593
	Pakistan	0	1	0	0		1	205
	Other	1,009	1,213	107	302	404	99	170
	Total [3]	4,169	3,850	1,611	1,938	5,359	8,935	8,600

[1] Market year is September-August.
[2] Grain only.
[3] May not add due to rounding.

Source: U.S. Department of Commerce, Bureau of the Census, Foreign Trade Statistics.

Date run: 10/14/2016

IMPORTS

Table 10. US Cereal Grain Imports by Country

U.S. imports of grains and grain products								
	Source	**Unit**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**
Total grains and products [1]								
	Canada		3,625.1	3,636.7	4,154.9	4,636.1	5,221.2	5,094.1

U.S. imports of grains and grain products							
Source	Unit	2009	2010	2011	2012	2013	2014
Total grains and products [1]							
Mexico		664.4	759.4	912.6	976.4	983.7	966.4
Thailand		466.6	515.6	539.8	574.7	617.7	603.8
Italy		313.9	319.3	361.6	397.5	404.4	462.4
India		168.4	182.8	206.4	232.9	266.4	290.8
Germany		159.7	163.4	202.2	223.8	256.1	284.6
Chile		154.5	160.6	168.8	278.7	370.7	251.0
Australia		127.2	170.8	153.2	144.3	218.9	228.5
China		116.8	140.8	169.7	177.3	191.9	200.9
Rest of World		1,238.2	1,257.8	1,360.1	1,800.0	2,305.0	2,000.5
World		7,034.9	7,307.3	8,229.3	9,441.6	10,835.8	10,383.1
Quantity	1000 mt	*8,541.7*	*8,327.4*	*8,258.4*	*10,451.1*	*12,922.4*	*11,132.4*
Bulk grains [2]							
Canada		1,186.7	1,012.4	1,296.6	1,669.8	2,096.3	1,788.9
Thailand		364.7	397.9	411.5	427.4	447.2	440.1
Chile		130.8	129.5	132.3	249.0	344.7	216.2
India		112.9	109.2	124.5	139.9	167.2	179.1
Argentina		64.9	39.9	53.8	106.6	370.3	141.3
Bolivia		0.4	0.2	0.6	30.0	64.1	84.0
Peru		3.0	3.1	6.1	15.0	30.9	73.8
Rest of World		198.0	157.3	167.0	487.9	566.7	373.1
World		2,061.5	1,849.6	2,192.4	3,125.6	4,087.3	3,296.5
Quantity	1000 mt	*5,844.9*	*5,410.2*	*5,246.0*	*7,343.6*	*9,691.8*	*7,648.0*
Wheat and products							
Canada		761.2	617.0	737.6	885.6	1,178.5	1,124.6
Australia		116.2	160.7	143.3	132.4	192.4	197.8
Germany		28.7	29.6	27.0	23.8	38.3	58.5
France		46.5	43.2	32.4	15.7	5.4	23.2
Rest of World		153.1	169.8	148.0	164.0	148.8	158.0
World		1,105.6	1,020.3	1,088.3	1,221.6	1,563.5	1,562.1
Quantity	1000 mt	*2,973.2*	*2,903.7*	*2,410.8*	*2,865.9*	*3,831.2*	*4,008.7*

-

Table 10. US Cereal Grain Imports (continued)

U.S. imports of grains and grain products							
Source	Unit	2009	2010	2011	2012	2013	2014
Rice and products							
Thailand		364.7	397.8	411.4	427.3	447.1	439.8
India		112.4	108.8	123.7	138.9	165.2	175.9
Pakistan		21.1	21.7	16.6	19.2	33.3	37.5
Vietnam		19.8	8.0	11.2	27.0	29.1	35.9
Rest of World		70.2	37.5	68.4	46.8	60.7	78.2
World		588.2	573.8	631.3	659.2	735.3	767.3
Quantity	1000 mt	*663.7*	*542.8*	*602.6*	*625.6*	*659.3*	*740.3*
Milled grain products [3]							
Canada		496.6	461.0	530.6	564.0	593.3	658.2
Australia		117.8	161.0	143.4	132.5	193.5	199.2
Germany		54.4	60.7	76.2	81.7	89.8	117.9
Mexico		42.2	39.8	41.8	46.5	54.1	56.4
Belgium-Lux.		36.2	43.2	48.1	50.6	59.4	56.2
United Kingdom		11.8	12.5	16.8	31.9	40.7	51.4
Thailand		17.1	30.1	36.5	42.2	48.1	48.5
Rest of World		230.3	236.5	247.2	215.3	234.5	250.0
World		1,006.4	1,044.7	1,140.7	1,164.7	1,313.4	1,437.9
Quantity	1000 mt	*1,339.1*	*1,435.9*	*1,462.6*	*1,512.1*	*1,588.4*	*1,764.4*
Cereal and bakery foods [4]							
Canada		1,941.8	2,163.3	2,327.7	2,402.3	2,531.7	2,646.9
Mexico		605.4	707.3	854.0	892.5	910.8	881.0
Italy		299.8	301.9	337.3	372.5	375.6	430.2
China		101.8	126.8	151.5	159.3	168.7	177.6
Germany		94.6	102.7	123.3	134.7	146.0	147.8
South Korea		65.9	81.3	91.1	98.0	114.1	128.0
Thailand		84.9	87.6	91.8	105.0	122.4	115.2
Rest of World		772.8	842.1	919.6	987.2	1,065.9	1,121.9
World		3,967.0	4,413.0	4,896.2	5,151.4	5,435.1	5,648.6
Quantity [5]	1000 mt	*1,357.8*	*1,481.3*	*1,549.8*	*1,595.4*	*1,642.3*	*1,719.9*

[1] Sum of bulk grains, milled grain products, and cereal and bakery preparations. Excludes grain for seed use. Excludes potato flour and meal.

[2] Excludes corn for seed use and canary seed. [3] Includes wheat and rice flour, and other grain products.

[4] Includes grain preparations, including pasta, baby food, baker mixes and doughs, wafers and biscuits. Excludes tapioca.

[5] Excludes malt extracts and food preparations, which are measured in liters.

Source: USDA, www.fas.usda.gov/gats.

U.S. CEREAL GRAIN PRODUCTION, GEOGRAPHICAL PRODUCTION, AND PER CAPITA AVAILABILITY (LB/YEAR):

The proposed members of the Cereal Grain crop groups are widely produced throughout the world. A comparison of production in the US, Canada and Mexico as well as the major world production countries is presented in Appendix 3, Table 2). Many of these crops are major crops (>300,000 acres) that are grown in the US including wheat (Appendix 4, [HYPERLINK \l "_Figure_2._All"] and [HYPERLINK \l "_Figure_3._All"]), barley ([HYPERLINK \l "_Figure_4._Barley"] and [HYPERLINK \l "_Figure_5._Barley"]), oats ([HYPERLINK \l "_Figure_6._Oats"] and [HYPERLINK \l "_Figure_7._Oats"]), rye ([HYPERLINK \l "_Figure_8._Rye"]), field corn ([HYPERLINK \l "_Figure_9._Corn"] and [HYPERLINK \l "_Figure_10._Corn"]), sweet corn ([HYPERLINK \l "_Figure_11._Sweet"]), grain sorghum ([HYPERLINK \l "_Figure_12._Sorghum"] and [HYPERLINK \l "_Figure_13._Sorghum"]) and rice ([HYPERLINK \l "_Figure_14._Rice,"]). Production of small grain hay is shown in [HYPERLINK \l "_Figure_15._Small"]. Numerous minor crops are also grown in the US including grain amaranth, buckwheat, tartary buckwheat, chia, pearl millet, popcorn, quinoa, teff, triticale, Inca, emmer and spelt (wheat varieties), and wild rice. [HYPERLINK \l "_Table_3._US"] provides total harvested acreage and percent of US harvested acres (2012) for the top producing states for wheat, grain; winter wheat for grain, spring wheat for grain; Durum wheat for grain, Emmer and spelt wheat for grain; and triticale for grain. Table 12 provides harvested acres for rye and barley for grain. Table 13 shows production of buckwheat and oats for grain. Table 14 shows production of field corn and popcorn. Table 15 provides harvested acres for popcorn, shelled and sorghum for grain. Table 16 provides harvested acres for proso millet and rice. Table 17 provides harvested acres for wild rice. [HYPERLINK \l "_Table_5._US"] provided total harvested acreage and percent of US harvested acres (2012) for the top producing states for small grains, hay and corn for silage or greenchop, while Table 19 has harvested acres for sorghum for silage or greenchop with the top two states being Kansas and Texas (62% of acres)..

Additional Crop Production Areas for the Cereal Grain Crop Group as applicable:

Grain amaranth, Princess Feather, and Inca Wheat:

According to the 2002 U.S. Census of Agriculture, 10 U.S. farms grew amaranth on 939 acres. It is also cultivated in Ethiopia, China, Bhutan, India, Nepal, Sri Lanka, Europe, Mexico, the Bolivia, Ecuador, Peru, and Argentina.

Barley:

In 2012, 3,283,905 acres were planted, producing 215,059,358 bushels (2012 CENSUS). The top 4 states included North Dakota (1,006,554 acres), Montana (778,521), Idaho (593,469), and Washington (175,074) which contains 77.8 acres (Table 14). It is widely cultivated and in 2012, the highest production regions for barley included the Russian Federation, Australia, Ukraine, Turkey, Spain and Canada (FAOSTAT).

Buckwheat, Tartiary buckwheat:

In 2012, 33,678 acres, with production of 754,128 bushels and the top 4 states included North Dakota (21,270 acres), Montana (2,816), New York (1,786), and Minnesota (1,038)and accounted for 80% of the total acres (Table 15). Other production regions include Ethiopia, Uganda, Zaire, Zimbabwe, South Africa, Reunion, Russian Federation, Kazakhstan, Mongolia, China, Japan, Korea, Bhutan, India, Nepal, Pakistan, Myanmar, Thailand, Vietnam, Australia, New Zealand, Poland, Belarus, Latvia, Lithuania, Russian Federation, Ukraine, Europe, Canada, Cuba, and Brazil. In 2012, the highest production regions for buckwheat included the Russian Federation, mainland China, Ukraine, United States, and Kazakhstan.

Canarygrass, annual:

Less than 3,000 acres annually have been contracted in Minnesota and North Dakota in recent years. It is grown under contract as a specialty crop in these regions, and is used primarily as birdfeed. In Canada, it is grown in Alberta, Saskatchewan and Manitoba. Worldwide production in 2013 was 232,999 tonnes. The top 5 producers were Canada, Argentina, Thailand, Australia and Hungary (FAOSTAT).

Cañihua:

It is cultivated in the high Andes of Peru and Bolvia. Grows at higher altitudes (up to 4,500 m) than quinoa.

Chia:

Australia is the world's top producer of chia. Other countries that grow chia commercially are Mexico, Bolivia, Peru, Argentina, Ecuador and Guatemala.

Corn, field, Popcorn, and Sweet corn (Tables 16 and 17):

In 2012, corn for grain was reported on 87,413,045 acres with production of 10,333,410,157 bushels (2012 CENSUS). The top 4 states of corn for grain included Iowa (13,709,408A), Illinois (12,263,259 A), Nebraska (9,087,851 A) and Minnesota (8,316,822 A). Popcorn was reported on 218,461 A with production of 785,685,762 pounds shelled. In 2012, the top 4 states for popcorn included Nebraska (70,879 A), Indiana (61,092 A), Ohio (27,680 A) and Illinois (26,296 A) which accounts for 85.1% of the total acres (Table 15). The highest production regions include the United States, China, mainland China, Brazil, India, Mexico, Nigeria and Ukraine (FAOSTAT).

Cram-cram:

It is native to Africa, and temperate and tropical Asia. Culivated in India and Australia.

Fonio, white; and Fonio, black:

It is native to Benin, Cote D'Ivoire, Nigeria and Togo. Cultivated in Africa. In 2012, the highest production regions for fonio included Guinea, Nigeria, Mali, Burkina Faso and Côte d'lvoire.

Huauzontle, grain:

It is cultivated in Mexico.

Job's tears:

It is cultivated in the tropics. Native to China, Taiwan, India, Indochina, Myanmar, Thailand, Malaysia, and the Philippines.

Millet, finger:

Cultivated in Africa, Oman, Afghanistan, Georgia, Armenia, China, Japan, Taiwan, India, Nepal, Sri Lanka, Indochina, Myanmar, Indonesia, Malaysia, Philippines, and Australia.

Millet, foxtail, and little millet:

In the United States, foxtail millet is primarily grown for hay. Foxtail millet does not produce as much biomass as pearl millet, but can produce 1 – 3.5 tons/A of hay. It is grown in China and Europe and widely cultivated in temperate and tropic regions

Millet, pearl:

Pearl millet has a long history of use as a summer grazing and hay crop in the southeastern United States. Pearl millet can reliably produce yields of 70 or more bushels of grain per acre with careful management. It is cultivated in Africa, China, India and the United States. In 2012, the highest production regions for millet included India, Niger, Nigeria, Mali, Sudan and Burkina Faso.

Millet, Proso (Table 16):

In 2012, Proso Millet was reported as 224,299 A with production of 3,622,387 bushels. In 2012, the top 4 states included Colorado (119,910 A), Nebraska (54,895 A), South Dakota (30,438 A), and North Dakota (4,808 A) and these states accounted for 91.6% of the harvested acres. It is cultivated in China, India, Nepal, Pakistan, Sri Lanka, Myanmar, Malaysia, and the Phillipines. The highest production regions for millet included India, Niger, Nigeria, Mali, Sudan and Burkina Faso (FAOSTAT).

Oat, Oat, Common, Oat, Naked (Table 13):

In 2012, oats for grain were reported as 1,078,698 A planted with 65,646,178 bushels. The top 6 states include Minnesota (130,729 A), Wisconsin (130,374 A), North Dakota (109,519 A), Texas (74,446 A), South Dakota (69,957 A) and Pennsylvannia (65,158 A) which account for 53.8 of the acres. Other production regions include Africa, France, Portugal, Spain, Denmark, United Kingdom, Austria, Belgium, Czech Republic, Germany, Greece, and across Europe. In 2012, the highest production regions for oats included the Russian Federation, Canada, Australia, Poland, Spain and the United States (FAOSTAT).

Oat, Abysinian:

Produced in Ethiopia.

Oat, sand;

Cultivated in United Kingdom, Lithuania, United States and Brazil.

Psyllium and Blond psyllium:

Psyllium research and field trials in the U.S. have been conducted mainly in Arizona and Washington states. It is native to Algeria, Egypt, Libya, Morocco, Tunisia, Cyprus, Egypt, Iran, Israel, Turkey, Armenia, Azerbaijan, Georgia, Russian Federation, Kazakhstan, Kyrgyzstan, Tajikistan, Pakistan, Austria, Czech Republic, Germany, Hungary, Poland, Slovakia Belarus, Latvia, Lithuania, Moldova, Ukraine, Albania, Bulgaria, Croatia, Greece, Italy, Romania, Serbia, Slovenia, France, Spain.

Quinoa:

Quinoa has been cultivated since the early 1980s and commercially produced since the mid 1980s in the Colorado Rockies, especially in the San Luis Valley. Production alsos starying in California, New Mexico, Oregon and Washington. The biggest barrier to U.S. production is climat. It is also cultivated in Bolivia, Colombia, Ecuador, Peru, Argentina and Chile. Native to Bolivia, Colombia, Ecuador, Peru, Argentina, and Chile. In 2012, the highest production regions for quinoa included Bolivia, Peru and Ecuador.

Rice (Table 16):

In 2012, rice was reported at 2,693,759 A with production of 200,239,288 cwt (2012 CENSUS). For rice, the 4 top states reporting were Arkansas (1,285,381 A), California (561,968 A), Louisiana (395,063 A), and Missouri (174,559 A) which account for 89.8% of the harvested acres. . Other production regions include Oriental countries, tropical Asia and throughout tropic, subtropic, and warm-temperate regions. In 2012, the highest production regions for rice (paddy) included India, China, mainland China, Indonesia, Thailand and Bangladesh.

Rice, Africian:

It is native to Africa and cultivated in the tropics

Rye (Table 12):

In 2012, 265,307 A were planted with 9,928,000 bushels of grain produced (2012 CENSUS). The top 6 states were included Oklahoma (82,870 A planted), Georgia (28,596 A), Texas (17,003 A), Kansas (15,212 A), North Carolina (13,104 A) and Virginia (90,000 A). In 2012, the highest production regions for rye included Russian Federation, Poland, Germany, Belarus, Ukraine and Spain (FAOSTAT).

Sorghum, grain (Table 17):

In 2012, 5,142,099 A harvested for sorghum grain with 264,337,547 bushels (2012 CENSUS). The top 6 states included Kansas (2,103,921 A), Texas (1,898,726A), Oklahoma (200,532 A), Colorado (147,955A), South Dakota (137,310 A) and Arkansas (133,660 A) which account for over 87% of the harvested acres. It is cultivated throughout tropic, subtropic, and warm temperate regions. In 2012, the highest production regions for sorghum included India, Nigeria, Sudan (former), Niger, United States and Mexico.

Teff:

It is grown in Northwest U.S. and Montana, Oklahoma and South Dakota. Largely remains an experimental crop, with limited numbers of acres grown for grain or as a livestock forage. It is also grown in Ethiopia.

Triticale (Table 11):

There was 1,428 A harvested with 3,303,077 bushels (2012 CENSUS). Most production as a grain is in the western states, and in southern states winter types are grazed in the fall. In 2012, the top 4 states included Kansas (14,883 A), California (14,677 A), Washington (5,446 A), and Colorado (3,173 A). In 2012, the highest production regions for triticale included Poland, Belarus, France, Germany, Russian Federation and mainland China.

Wheat (Tables 11):

In 2012, 34,723,361 A harvested with production of 1,577,093,637 bushels of winter wheat (2012 CENSUS). In 2012, durum wheat 2,139,150 A harvested with 86,110,218 bushels. In 2012, other spring wheat 12,177,715 A harvested with 521,904,259 bushels. Durum wheat acres in North Dakota and Montana account for 88% of he total harvested acres. For all wheat in 2012, 49,040,226 A with 2,185,108,114 bushels. In 2012, the top 6 states for all wheat included Kansas (9,009,535 A), North Dakota (7,767,484 A), Montana (5,627,463 A), Oklahoma (4,291,939 A), Texas (2,993,969 A) and South Dakota (2,203,785 A). It is widely cultivated, and in 2012, the highest production regions for wheat included India, China, mainland China, Russian Federation, United States, Kazakhstan and Australia.

Wheat, club:

Cultivated in Egypt, Israel, Jordan, Lebanon, Syria, Turkey, Armenia, Azerbaijan, Russian Federation, Kazakhstan, Kyrgyzstan, Tajikistan, Uzbekistan, Norway, Czech Republic, Germany, Slovakia, Ukraine, Italy and Romania.

Wheat, Emmer:

In 2012, Emmer and Spelt wheats reported a US total of 14,036 A with the top four states reporting 3,130 A New York, 3,079A, Ohio, 2,423 A, Pennsylvania and 1,528 acres Michigan.

Wheat, Persian:

Cultivated in Iran, Iraq, Turkey, Armenia, Azerbaijan, Georgia and Russian Federation.

Wheat, Poulard:

Cultivated in Algeria, Ethiopia, Turkey, Armenia, Azerbaijan, Georgia, Russian Federation, Kazakhstan, Kyrgyzstan, Turkmenistan, Ukraine, Italy and Spain.

Wheat, Spelt:

In 2012, Emmer and Spelt wheats reported a US total of 14,036A with the top four states reporting 3,130 A New York, 3,079 A Ohio, 2,423 A Pennsylvania and 1,528 A Michigan.

Wheat, Timopheevi:

Cultivated in Georgia.

Wheat, Vavilov:

Cultivated in Turkey, Armenia and Azerbaijan.

Wheat, Wild einkorn:

Cultivated in Afghanistan, Iran, Iraq, Lebanon, Syria, Turkey, Armenia, Azerbaijan, Georgia, Ukraine, Albania, Bulgaria, Greece, Montenegro and Serbia.

Wheat, wild emmer:

It is producrd in Iran, Iraq, Israel, Jordan, Lebanon, Syria and Turkey.

Wheatgrass, Intermediate:

This is a perennial cool season sod-forming wheatgrass, introduced from Eurasia. It has proved well adapted to the Northern and Central Great Plains, and in the Pacific Northwest, as well as Canada. It is adapted to areas with rainfall > 350 mm and elevations up to 3000 m.

Wild rice and Eastern Wild rice:

For wild rice (Table 17) in 2012, 47,333 A with 1,156,225 cwt (2012 CENSUS), with the top two reporting states of Minnesota (34,365 A), and California (12,010 A) producing 98% of the harvested acres. Canada also produces wild rice.

Table 11. US Cereal Grain Production by State for 2012

Wheat, all, for grain			Winter Wheat, for grain		
State	**Total Harvested Acres (2012)**	**% of Total US Harvested Acres (2012)**	**State**	**Total Harvested Acres (2012)**	**% of Total US Harvested Acres (2012)**
Kansas	9,009,535	18.4	Kansas	9,009,535	25.9
North Dakota	7,767,484	15.8	Oklahoma	4,291,939	12.4
Montana	5,627,463	11.5	Montana	2,168,021	6.2
Oklahoma	4,291,939	8.8	Colorado	2,167,930	6.2
Texas	2,993,969	6.1	Washington	1,669,175	4.8
South Dakota	2,203,785	4.5	Nebraska	1,302,674	3.8
Washington	2,186,813	4.5	South Dakota	1,208,309	3.5
Colorado	2,181,967	4.4	Oregon	782,209	2.3
Minnesota	1,354,928	2.8	North Carolina	753,489	2.2
Nebraska	1,309,269	2.7	Idaho	738,354	2.1
Idaho	1,250,494	2.5	North Dakota	729,244	2.1
Oregon	906,013	1.8	Missouri	689,965	2.0
North Carolina	753,713	1.5	Illinois	645,829	1.9
Missouri	690,245	1.4	Michigan	538,880	1.6
Illinois	645,829	1.3	Ohio	469,840	1.4
Michigan	539,138	1.1	Kentucky	468,242	1.3
California	491,846	1.0	Arkansas	448,235	1.3
Ohio	469,840	1.0	Mississippi	346,310	1.0
Kentucky	468,242	1.0	Tennessee	328,209	0.9
Arkansas	448,235	0.9	California	316,109	0.9
US Total	49,040,226	93.0	US Total	34,723,361	83.7

Table 11. US Cereal Grain Production by State for 2012 (continued)

Spring Wheat, for grain	Durum Wheat, for grain

State	Total Harvested Acres (2012)	% of Total US Harvested Acres (2012)	State	Total Harvested Acres (2012)	% of Total US Harvested Acres (2012)
North Dakota	5,708,405	46.9	North Dakota	1,329,835	62.2
Montana	2,909,910	23.9	Montana	549,532	25.7
Minnesota	1,319,274	10.8	California	135,540	6.3
South Dakota	991,083	8.1	Arizona	98,072	4.6
Washington	514,374	4.2	Idaho	12,517	0.6
Idaho	499,623	4.1	South Dakota	4,393	0.2
Oregon	122,897	1.0	Washington	3,264	0.2
California	40,197	0.3	Colorado	1,462	0.1
Wisconsin	16,253	0.1	Oregon	907	0.04
Utah	13,315	0.1			
Colorado	12,575	0.1			
Nebraska	6,595	0.1			
Texas	4,856	0.04			
Virginia	1,771	0.01			
New York	1,259	0.01			
Iowa	503	0.004			
Missouri	280	0.002			
Michigan	258	0.002			
North Carolina	224	0.002			
Alaska	182	0.001			
US Total	12,177,715	99.9	US Total	2,139,150	99.8

Table 11. US Cereal Grain Production by State for 2012 (continued)

Emmer and Spelt Wheat, for grain			**Triticale, for grain**		
State	Total Harvested Acres (2012)	% of Total US Harvested Acres (2012)	State	Total Harvested Acres (2012)	% of Total US Harvested Acres (2012)
New York	3,130	22.3	Kansas	14,883	24.2
Ohio	3,079	21.9	California	14,677	23.9
Pennsylvania	2,423	17.3	Washington	5,446	8.9
Michigan	1,528	10.9	New York	4,109	6.7
Montana	1,338	9.5	Colorado	3,173	5.2
Washington	822	5.9	Texas	2,965	4.8
Missouri	558	4.0	North Carolina	1,869	3.0
Indiana	441	3.1	Idaho	1,445	2.4
Wisconsin	153	1.1	Nebraska	1,324	2.2
North Dakota	132	0.9	Pennsylvania	1,124	1.8
Kentucky	122	0.9	Oregon	1,079	1.8
West Virginia	53	0.4	South Dakota	965	1.6
Illinois	42	0.3	Wisconsin	915	1.5
Colorado	36	0.3	Oklahoma	906	1.5
Kansas	27	0.2	Montana	524	0.9
			Virginia	515	0.8
			Utah	466	0.8
			Wyoming	438	0.7
			Minnesota	370	0.6

			Missouri	142	0.2
US Total	14,036	98.9	US Total	61,428	93.3

Table 12. US Cereal Grain Production by State for 2012.

Rye, for grain			Barley, for grain		
State	**Total Harvested Acres (2012)**	**% of Total US Harvested Acres (2012)**	**State**	**Total Harvested Acres (2012)**	**% of Total US Harvested Acres (2012)**
Oklahoma	82,870	31.2	North Dakota	1,006,554	30.7
Georgia	28,596	10.8	Montana	778,521	23.7
Texas	17,033	6.4	Idaho	593,469	18.1
Kansas	15,212	5.7	Washington	175,074	5.3
North Carolina	13,104	4.9	Minnesota	99,643	3.0
Michigan	11,454	4.3	California	81,954	2.5
Wisconsin	10,552	4.0	Wyoming	62,590	1.9
Minnesota	10,017	3.8	Colorado	54,828	1.7
Pennsylvania	9,962	3.8	Oregon	53,898	1.6
Nebraska	6,837	2.6	Pennsylvania	52,853	1.6
North Dakota	6,458	2.4	Arizona	44,662	1.4
New York	6,253	2.4	Maryland	40,133	1.2
South Carolina	6,226	2.3	Virginia	37,023	1.1
South Dakota	6,113	2.3	Delaware	33,455	1.0
Virginia	4,291	1.6	Utah	25,908	0.8
Maine	4,168	1.6	South Dakota	23,131	0.7
Florida	2,942	1.1	Wisconsin	20,315	0.6
Alabama	2,789	1.1	North Carolina	16,695	0.5
Illinois	2,637	1.0	Maine	15,324	0.5
New Jersey	2,403	0.9	Michigan	9,571	0.3
US Total	265,307	94.2	US Total	1,006,554	98.2

Table 13. US Cereal Grain Production by State for 2012.

Buckwheat, for grain			Oats, for grain		
State	**Total Harvested Acres (2012)**	**% of Total US Harvested Acres (2012)**	**State**	**Total Harvested Acres (2012)**	**% of Total US Harvested Acres (2012)**
North Dakota	21,270	63.2	Minnesota	130,729	12.1
Montana	2,816	8.4	Wisconsin	130,374	12.1
New York	1,786	5.3	North Dakota	109,519	10.2
Minnesota	1,038	3.1	Texas	74,446	6.9
Oregon	581	1.7	South Dakota	69,957	6.5

Buckwheat, for grain			Oats, for grain		
State	Total Harvested Acres (2012)	% of Total US Harvested Acres (2012)	State	Total Harvested Acres (2012)	% of Total US Harvested Acres (2012)
Pennsylvania	572	1.7	Pennsylvania	65,158	6.0
Michigan	304	0.9	Iowa	57,259	5.3
Ohio	239	0.7	New York	50,543	4.7
Maine	205	0.6	Ohio	45,833	4.2
Missouri	149	0.4	Michigan	35,420	3.3
Washington	27	0.1	Kansas	29,802	2.8
Wisconsin	9	0.03	Maine	28,725	2.7
West Virginia	4	0.01	California	25,065	2.3
South Dakota	3	0.01	Georgia	20,087	1.9
Virginia	2	0.01	Illinois	19,769	1.8
			Oregon	18,899	1.8
			Nebraska	17,788	1.6
			Montana	17,084	1.6
			South Carolina	15,464	1.4
			Alabama	15,069	1.4
US Total	33,678	86.1	US Total	1,078,698	90.6

Table 14. US Field Corn and Sweet Corn Production by State for 2012.

Field Corn, for grain			Sweet Corn		
State	Total Harvested Acres (2012)	% of Total US Harvested Acres (2012)	State	Total Harvested Acres (2012)	% of Total US Harvested Acres (2012)
Iowa	13,709,408	15.7	Minnesota	106,858	18.7
Illinois	12,263,259	14.0	Washington	90,671	15.8
Nebraska	9,087,851	10.4	Wisconsin	78,245	13.7
Minnesota	8,316,822	9.5	Florida	35,225	6.2
Indiana	6,036,712	6.9	California	32,667	5.7
South Dakota	5,289,110	6.1	Oregon	32,500	5.7
Kansas	3,948,462	4.5	New York	28,586	5.0
Ohio	3,630,624	4.2	Georgia	21,450	3.7
North Dakota	3,465,997	4.0	Illinois	18,227	3.2
Wisconsin	3,306,621	3.8	Pennsylvania	12,715	2.2
Missouri	3,302,499	3.8	Michigan	10,192	1.8
Michigan	2,393,504	2.7	Ohio	9,742	1.7
Texas	1,620,460	1.9	Delaware	9,587	1.7
Kentucky	1,530,189	1.8	Idaho	9,292	1.6
Pennsylvania	998,376	1.1	Maryland	8,182	1.4
Tennessee	960,721	1.1	New Jersey	7,139	1.2
North Carolina	803,020	0.9	Indiana	6,050	1.1
Mississippi	793,762	0.9	North Carolina	5,276	0.9
New York	677,268	0.8	Massachusetts	4,985	0.9
Louisiana	524,008	0.6	Colorado	4,885	0.9

US Total	87,413,045	94.6	US Total	572,068	93.1

Table 15. US Popcorn and Grain Sorghum Production by State for 2012.

Popcorn, shelled			Sorghum for grain		
State	Total Harvested Acres (2012)	% of Total US Harvested Acres (2012)	State	Total Harvested Acres (2012)	% of Total US Harvested Acres (2012)
Nebraska	70,879	32.4	Kansas	2,103,921	40.9
Indiana	61,092	28.0	Texas	1,898,726	36.9
Ohio	27,680	12.7	Oklahoma	200,532	3.9
Illinois	26,296	12.0	Colorado	147,955	2.9
Kentucky	7,448	3.4	South Dakota	137,310	2.7
Iowa	6,471	3.0	Arkansas	133,660	2.6
South Dakota	5,912	2.7	Louisiana	125,098	2.4
Missouri	3,911	1.8	Nebraska	60,010	1.2
Michigan	2,034	0.9	Missouri	54,885	1.1
Tennessee	1,067	0.5	Mississippi	46,412	0.9
Wisconsin	922	0.4	Georgia	3,9082	0.8
Pennsylvania	384	0.2	Illinois	26,494	0.5
Kansas	121	0.055	North Carolina	19,819	0.4
New York	20	0.009	New Mexico	19,445	0.4
Virginia	12	0.005	Maryland	14,772	0.3
Georgia	9	0.004	South Carolina	14,012	0.3
North Carolina	6	0.003	California	13,908	0.3
Massachusetts	6	0.003	Tennessee	11,496	0.2
Minnesota	4	0.002	Arizona	10,412	0.2
Vermont	4	0.002	Indiana	7,282	0.1
US Total	218,462	98.1	US Total	5,142,099	98.9

Table 16. US Proso Millet and Rice Grain Production by State for 2012.

Proso Millet			Rice		
State	Total Harvested Acres (2012)	% of Total US Harvested Acres (2012)	State	Total Harvested Acres (2012)	% of Total US Harvested Acres (2012)
Colorado	119,910	53.5	Arkansas	1,284,381	47.7
Nebraska	54,895	24.5	California	561,968	20.9
South Dakota	30,438	13.6	Louisiana	395,063	14.7
North Dakota	4,808	2.1	Missouri	174,559	6.5
Texas	3,788	1.7	Texas	134,189	5.0
Kansas	2,195	1.0	Mississippi	129,405	4.8
Wyoming	1,766	0.8	Tennessee	645	0.02
Florida	1,475	0.7			
Georgia	1,187	0.5			
Montana	1,165	0.5			
South Carolina	693	0.3			

Alabama	594	0.3			
North Carolina	434	0.2			
US Total	224299	99.6	US Total	2,693,759	99.5

Table 17. US Wild Rice Grain Production by State for 2012.

Wild Rice		
State	Total Harvested Acres (2012)	% of Total US Harvested Acres (2012)
Minnesota	34,365	72.6
California	12,010	25.4
Oregon	150	0.3
US Total	47,333	98.3

Source: 2012 Census of Agriculture – State Data, USDA, National Agricultural Statistics Service, https://www.agcensus.usda.gov/Publications/2012/

Table 18. US Small Grain Hay Corn for Silage or Greenchop Production by State for 2012.

Small Grain, Hay			Corn for Silage or Greenchop		
State	Total Harvested Acres (2012)	% of Total US Harvested Acres (2012)	State	Total Harvested Acres (2012)	% of Total US Harvested Acres (2012)
Texas	739,656	19.6	Wisconsin	953,876	13.3
Oklahoma	496,500	13.2	South Dakota	592,643	8.2
California	370,695	9.8	New York	496,885	6.9
Montana	183,378	4.9	California	487,570	6.8
Kansas	165,804	4.4	Nebraska	446,386	6.2
North Dakota	154,181	4.1	Pennsylvania	412,695	5.7
South Dakota	138,538	3.7	Iowa	392,304	5.5
Missouri	101,156	2.7	Minnesota	361,189	5.0
Nebraska	99,990	2.7	Kansas	337,083	4.7
Colorado	89,426	2.4	Michigan	309,709	4.3
Kentucky	80,356	2.1	Idaho	232,143	3.2
Tennessee	78,131	2.1	Ohio	199,563	2.8
Pennsylvania	75,575	2.0	Texas	186,995	2.6
Wisconsin	72,349	1.9	Illinois	171,562	2.4
Oregon	67,792	1.8	Colorado	157,285	2.2
New Mexico	63,547	1.7	North Dakota	151,096	2.1
Idaho	61,639	1.6	Missouri	148,805	2.1
Virginia	55,949	1.5	Indiana	137,801	1.9
Utah	53,037	1.4	Virginia	113,059	1.6
New York	49,863	1.3	Washington	93,239	1.3
US Total	3,766,465	84.9	US Total	7196,628	88.7

Table 19. US Grain Sorghum for Silage or Greenchop Production by State for 2012.

Sorghum for Silage or Greenchop		
State	Total Harvested Acres (2012)	% of Total US Harvested Acres (2012)
Kansas	136,262	29.2
Texas	110,679	23.7
California	41,953	9.0
New Mexico	17,288	3.7
Arizona	16,226	3.5
South Dakota	14,946	3.2
Georgia	14,613	3.1
Nebraska	11,677	2.5
Colorado	11,209	2.4
Pennsylvania	9,475	2.0
Oklahoma	8,940	1.9
Florida	8,385	1.8
Missouri	7,873	1.7
South Carolina	6,694	1.4
Wisconsin	6,327	1.4
North Carolina	4,313	0.9
Virginia	4,129	0.9
Maryland	4,123	0.9
Arkansas	3,397	0.7
Illinois	3,271	0.7
US Total	466,645	94.7
Source: 2012 Census of Agriculture – State Data, USDA, National Agricultural Statistics Service, https://www.agcensus.usda.gov/Publications/2012/		

PER CAPITA CONSUMPTION AND AVAILABILITY, USDA ERS, USDA CSFII (1994-1996, 1998).

Per capita consumption data for 1970, 1980, 1990, 2000, 2005, 2010, 2011, 2012, 2013 and 2014 are shown in [HYPERLINK \l "_Appendix_4._Consumption"] (wheat and rye flour), [HYPERLINK \l "_Appendix_4._Consumption"] (oat and barley products), [HYPERLINK \l "_Appendix_4._Consumption"] (rice) and [HYPERLINK \l "_Appendix_4._Consumption"] (corn). Per capita consumption of wheat flour greatly increased from the 1970s and 1980s to 1990 through 2014, while rye flour decreased. The consumption of oat and barley products have remained steady from 2000 to 2014. The consumption of rice nearly tripled from 1970 to 2010 (Table 22). The consumption of corn products increased greatly from the 1970s, 1980s and 1990s to 2000 and then remained steady from 2000 to 2014 (Table 23).

Table 20. Wheat and Rye Flour Per capita Availability [1]

Year	Wheat Flour: White and Whole Wheat (pounds)	Wheat Flour: Durum Flour (pounds) [2]	Wheat Flour: Total (pounds)	Rye Flour (pounds)
1970	104.0	6.9	110.9	1.2
1980	110.3	6.6	116.9	0.7
1990	124.2	11.4	135.6	0.6
2000	133.7	12.6	146.3	0.5
2005	122.6	11.8	134.4	0.5
2010	122.9	12.0	134.8	0.5
2011	NA	NA	132.5	0.5
2012	NA	NA	134.3	0.5
2013	NA	NA	135.0	0.5
2014	NA	NA	134.7	0.5

Source: USDA ERS Food Availability, February 1, 2016, USDA Agricultural Statistics

[1] Consumption of most items at the processing level. Excludes quantities used in alcoholic beverages and fuel.
[2] Semolina and durum flour in products such as macaroni, spaghetti and noodles. Includes blended semolina since 1984.

Table 21. Oat and Barley Products Per capita Availability [1]

Year	Oat Products (pounds) [2]	Barley Products (pounds) [3]
1970	4.8	1.0
1980	3.9	1.0
1990	6.5	0.8
2000	4.4	0.7
2005	4.6	0.7
2010	4.7	0.7
2011	4.8	0.7
2012	4.7	0.6
2013	4.5	0.7
2014	4.5	0.7

Source: USDA ERS Food Availability, February 1, 2016, USDA Agricultural Statistics

[1] Consumption of most items at the processing level. Excludes quantities used in alcoholic beverages and fuel.
[2] Includes rolled oats, ready-to-eat oat cereals, oat flour, and oat bran.
[3] Includes barley flour, pearl barley, and malt and malt extract used in food processing.

Table 22. Rice per Capita Availability [1]

Year	Rice (pounds) [2]

Year	Rice (pounds) [2]
1970	7.7
1980	11.0
1990	16.2
2000	19.2
2005	19.4
2010	20.4
2011	NA
2012	NA
2013	NA
2014	NA
Source: USDA ERS Food Availability, February 1, 2016, USDA Agricultural Statistics	

[1] Consumption of most items at the processing level. Excludes quantities used in alcoholic beverages and fuel.
[2] Milled basis.

Table 22. Corn per Capita Availability [1]

	Corn Products [2]			
Year	Flour and meal (pounds)	Hominy and Grits (pounds)	Food Starch (pounds)	Total (pounds)
1970	7.0	2.2	1.9	11.1
1980	7.4	2.8	2.7	12.9
1990	14.4	2.9	4.0	21.4
2000	17.5	6.2	4.7	28.4
2005	18.8	8.1	4.5	31.4
2010	19.3	9.3	4.5	33.1
2011	19.9	9.6	4.6	34.1
2012	19.8	9.5	4.6	33.9
2013	19.8	9.5	4.6	33.9
2014	19.9	9.5	4.6	34.0
Source: USDA ERS Food Availability, February 1, 2016, USDA Agricultural Statistics				

[1] Consumption of most items at the processing level. Excludes quantities used in alcoholic beverages and fuel.
[2] Based on Census of Manufactures. Does not include data on corn sugar and corn syrup.

CEREAL GRAIN CONSUMPTION (WWEIA-FCID 2005-2010):

Based on the What We Eat In America – Food Commodity Intake Database (WWEIA-FCID) survey, using two-day individual consumption for cereal grain consumption (g food/kg body weight) is listed in Table 23. The highest reported consumed cereal grain is wheat flour at

1.44 g/kg and accounts for 42% of the total consumption. Sweet corn and rice account for 0.13 g/kg and 0.23 g/kg/day. Total cereal grain crop group 15 consumption is 3.5 g/kg body weight.

Table 23. Per Capita Mean Consumption of Cereal Grains for the US General Population, based on the WWEIA-FCID 2005-2010, S. Nako, June 8, 2018:

COMMODITY	MEAN CONSUMPTION (g/kg body weight)	Percent (%)
Barley	<0.1	
Buckwheat flour	0.12	3.6%
Buckwheat grain	<0.1	
Corn, grain	0.15	4.5%
Corn, flour	<0.1	
Corn, oil	<0.1	
Millet	<0.1	
Oat	0.12	3.6%
Rice	0.23	6.9%
Rice flour	<0.1	
Rice bran, unprocessed	<0.1	
Rye	<0.1	
Rye flour	<0.1	
Sorghum grain	<0.1	
Sweet corn kernels	0.13	3.9%
Triticale flour	<0.1	
Wheat	0.10	3%
Wheat bran processed	<0.1	
Wheat flour	1.44	42%
Wheat germ	<0.1	
Wild rice	<0.1	
Other processed products (Corn syrup)	0.92	26.8%
Total Cereal Grain Consumption	**3.5**	

COMPARISON OF CEREAL GRAIN GENERAL INFORMATION INCLUDING CULTURAL PRACTICES:

General and Specific Cultural Practices:

Table 24. General Information and Specific Cutural Practices for Each Cereal Grain Commodity:

Crop	General Information and Cultural Practices
Amaranth, grain	The seeds of the amaranths are used as grain. The seed protein is almost comparable to milk protein in nutritional quality. Crop is resistant to drought. The seeds are about the size of poppy seeds and plants have about 100,000 or more seeds each. They are annuals growing to 7 feet tall with inflorescences to 3 feet, like a cattail. Young leaves of *A. cruentus* and *hybridus* are used as a pot herb and a member of Leafy vegetable crop group 4 - 16.
Barley	Barley is one of the top 5 important grain crops in the United States. Types and Characteristics of Barley include: Three types of *Hordeum vulgare* constitute the barleys under cultivation. They are derived types not known as such in nature. All have 14 chromosomes in the diploid stage and inter-cross readily. They are characterized as follows: 1) These are 6-rowed barleys with a tough rachis or spike stem. All florets are fertile and develop normal kernels. 2) This type is the 2-rowed barleys with a tough rachis. The central spikelets all contain a fertile flower, while flowers in the lateral spikelets are either male or sexless. 3) This is an irregular barley with a tough rachis, but with lateral flowers reduced in some instances to a stem piece only, and others fertile, sterile or sexless. Central spikelets contain fertile flowers and set seeds. Barley plants are annual grasses which may be either winter annuals or spring annuals. Winter annuals require a period of exposure to cold to produce flowers and set seeds, thus are planted in the fall. They form a rosette type of growth in fall and winter, developing elongated stems and flower heads in early summer. If seeded in the spring they fail to produce seed heads. Winter varieties form branch stems or tillers at the base so several stems rise from a single plant. The winter varieties of barley are hardier than winter oats, but somewhat less hardy than winter wheat. Around 25% of the barley grown in the United States is of winter varieties. Spring varieties do not require exposure to cold to develop seed heads. Also, they do not have a typical rosette stage and so develop fewer tillers than

Crop	General Information and Cultural Practices
	winter varieties. They are the only kind adapted to areas with very cold winters. For best production, they should be seeded as early as land can be worked in the spring. The stems of both winter and spring varieties may vary in length from 1 to 4 feet, depending on variety and growing conditions. Stems are round, hollow between nodes, and develop 5 - 7 nodes below the head. At each node, a clasping leaf develops. In most varieties, the leaves are coated with a waxy chalk like deposit. Shape and size of leaves varies with variety, growing conditions, and position on the plant. The spike, which contains the flowers and later the mature seeds, consists of spikelets attached to the central stem or rachis. Barley varieties are classed as 2-row or 6-row. In 2-row varieties only the central spikelet develops a fertile flower and seed. In 6-row varieties all three of the spikelets at each node develop a seed. The awns on the glumes may be shorter than the glume, equal in length or longer. The glumes are removed in threshing. The barley kernel consists of the caryopsis, or internal seed, the lemma and palea. In most barley varieties, the lemma and palea adhere to the caryopsis and are a part of the grain following threshing. However, naked or hulless varieties also occur. In these the caryopsis is free of the lemma and palea and threshes out free as in wheat. This type is grown mainly where barley is used for human food and is rarely found in the United States. The lemmas in barley are usually awned. Awns vary from very short up to as much as 12 inches in length. Edges of awns may be rough or "barbed" (bearded) or nearly smooth. Awnless varieties are also known. In 6-row barley awns are usually more developed on the central spikelets than on the lateral ones. The barley kernel is generally spindle shaped. In commercial varieties grown in the United States length ranges from 7 - 12 mm. Kernels from 2-rowed varieties are symmetrical. In 6-rowed varieties the third of the kernels from the central spikelets are symmetrical, but the two-thirds from lateral spikelets are twisted. The twist is most apparent at the attachment end, less conspicuous at the terminal. The dorsal surface of kernels is smooth, the ventral surface grooved. The period from flowering until barley is ready for harvest may vary from 40 - 55 days, varying with varieties and climate conditions. Cultivated Variety Groups Some 150 varieties of barley are cultivated in the United States, many on a minor scale. Varieties are constantly changing as new ones are developed and tested while others pass out of cultivation. These varieties fall into four general groups, as follows: Manchuria, OAC 21, Aderbrucker Group. These are 6-rowed, awned, spring-type varieties with medium sized kernels. The type is believed to have come originally from Manchuria. They tend to

Crop	General Information and Cultural Practices
	shatter badly in dry climates. These are grown mainly in the upper Mississippi Valley and are extensively used for malting. Coast Group. These varieties trace to North African ancestry and are grown in California and Arizona, also in the Intermountain Region. They are 6-rowed, awned, with large kernels, and short to medium length stems. They mature early and are not prone to shatter. They have a spring growth habit but may be fall or winter seeded in California and Arizona where winters are mild. Tennessee Winter Group. Varieties of this group trace to the Balkan Caucasus Region or Korea. Plants are medium tall, of winter habit. These varieties are fall seeded and are grown in the southeastern quarter of the United States. Two-rowed Group. This group includes types tracing to Europe and Turkey, the Turkish type being adapted to areas with marginal rainfall. Varieties in this group are grown principally in the Pacific and Inter Mountain States and to some extent in the Northern Great Plains. Varieties are mainly spring type though 2-rowed winter varieties are known. Some varieties are used mainly for malting, others for feed. Barley cultivars in U.S. are classified as malting or feed types. In the rest of the world, barley is a major human food grain. Most malting types are produced along the Red River Valley of Minnesota and North Dakota and irrigated Inter Mountain States of Idaho, Wyoming and Montana. It is estimated that 25% of the total U.S. barley acreage is planted to winter types.
Buckwheat	Buckwheat is believed to have originated in Central and Western China. It is now a relatively minor crop in the United States. The buckwheat plant is entirely different from other grains and is not a grass. It is a summer annual and its growth habit is indeterminate with flowers opening throughout a long season so the seed crop does not mature at one time. The seed is partially but not entirely enclosed by adhering flower parts during development. Buckwheat is usually seeded only after the ground is thoroughly warm in early summer. Plants will begin blooming in about 40 days from seeding and first seeds mature about 35 days later. Harvesting is done when a substantial part of the seed is ripe. Fields are then mowed and plants are stacked to dry before they can be threshed. Seeds are pointed, broad at the base, and triangular to nearly round in cross section. They vary in size in different kinds from about 4 mm at maximum width and 6 mm. long to 7 mm. wide and 4 mm. long. The seed consists of an outer layer or hull, an inner layer, the seed coat proper, and within this a starchy endosperm and the germ. The Japanese buckwheat is most widely grown in this country. The seeds are large, brown in color, and triangular in cross section.

Crop	General Information and Cultural Practices
	Plants are about 40 inches tall, rather coarse growers with large, broad arrow-shaped leaves. Silverhull plants are smaller than Japanese buckwheat with smaller leaves. The seeds are small, nearly round in cross section, glossy and gray in color. The hulls are thinner than in Japanese. Tartary buckwheat has small seeds, nearly round in cross section. Color varies from gray to black. The hull may be smooth to rough and spiny. Leaves are relatively small, narrow and arrow-shaped. Plants may be almost viny in habit. The flour from Tartary buckwheat is inferior to that from Japanese or Silverhull and is not used to make pancake flour. Tartary buckwheat has a lower feeding value than the common variety and is used mostly for poultry and cattle feed. Buckwheat hulls have little feeding value, sold as feed or bran, or used as soil mulch or poultry litter in U.S. or for stuffing pillows in Japan. Buckwheat is used in commercial birdseed mixtures.
Canarygrass, annual	This is a cool season bunchgrass native to the Mediterranean region and has been introduced into the U.S. Commercial production in the US started in the 1950s and cultivation spread to Canada in the 1970s. There is production in the northern Red River valley of North Dakota and Minnesota and the Canadian provinces of Alberta, Saskatchewan, and Manitoba. Annual canarygrass is often classified as a grain crop, and are often confused with Reed canarygrass which is a forage. Both species have inflorescences called panicles, but annual canarygrass are more spike-like and resemble club wheat. The plant grows to 60 - 100 cm tall, and readily tillers with it heading in 65 days and maturing in 104 - 107 days which is like spring wheat. The mature fruits conist of a fertile floret and two reduced sterile basal florets. Canarygrass has small elliptical grains with hulls covered with fine siliceous hairs or trichomes. Annual canarygrass are adapted to the same climatic areas as spring wheat, and perform better on heavier clay loam soils. It is planted early in the spring as soon as the ground can be worked which is late March or April in southern Minnesota or central Wisconsin. The primary market for annual canarygrass is currently birdseed, but several other uses including flour and it must be dehulled before it is milled. Annual to 2 feet tall, erect; panicles ovate to oblong-ovate, dense to 5/8" long. Reed canarygrass is perennial and used for forage.
Cañihua	*Chenopodium* is a genus of about 150 species of flowering plants. It contains several plants of minor to moderate importance as food crops, both leaf vegetables and pseudocereals, including quinoa and cañihua. Cañihua, which originated in the Andes of southern Peru and Bolivia, was domesticated by the settlers of Tiahuanaco, who established themselves on the tableland of Collao. Cañihua is important on the high plateau of Peru and Bolivia because it

Crop	General Information and Cultural Practices
	produces grains for human consumption at between 3,800 and 4,300 meters, being very cold-resistant in its various phenological phases.
Chia	Chia is an annual grown in Mexico, Guatemala and South America. Plants grow to 60 cm (2 ft tall with glabrous leaves which are ovate and 5 - 7.6 cm (2 - 3 in) long. It is grown as either a winter or summer annual depending on the location, and in some places, different varieties may be grown in the winter and summer. It is grown primarily for its seed, which is a rich source of protein and omega-3 fatty acids. The seeds become thick and gelatinous when soaked in water, and are used as a thickener for soups and sauces, as well as flavored with fruit juice and consumed as a beverage. The seeds may also be ground into a nutritious meal, or pressed for cooking oil. Use of chia seed in this manner is relatively recent.
Corn	Indians in the Americas were growing corn extensively long before the discovery of these continents by Europeans. Archaeological studies indicate that corn was cultivated in the Americas at least 5,600 years ago. The exact origin of corn is unknown as the plant is found only under cultivation. The probable center of origin is the Central American and Mexico region. The corn plant is a warm weather annual, deep-rooted but requiring abundant moisture for best development. From a seed a single stalk arises that will reach from 2 to near 20 feet depending on kind and growing conditions. This stalk terminates in the tassel or staminate flowers. At the stem nodes are attached the large, smooth leaves which may be more than 2 feet long and 2 inches wide along the mid-point of the stem. At the base of the main stem side shoots or suckers commonly rise, which may produce seeds. The female flowers are borne on a receptacle, termed ear, which arises at a leaf axil near the mid-point along the stem. Normally one to three or more such ears develop. The flower organs, and later the grain kernels, are enclosed in several layers of papery tissue, termed husks. Strands of "silk", the stigmas from the flowers, emerge from the terminals of the ears and husks at the same time the pollen from the terminal tassels is shed. The pollen is wind-blown and meets the emerged silk or stigma. The pollen then germinates and a pollen tube grows down through the silk to the egg cell of the female flower. The male gamete fuses with the egg, and from the fertilized egg the corn seed or kernel develops. Most varieties of corn require 100 to 140 days from seeding to full ripeness of the kernels though some kinds will ripen in as little as 80 days. The time of pollen shed and fertilization of the egg is a little after the midpoint of this period. Corn kernels or seeds vary in size and shape in different kinds and varieties. They may be only an eighth inch long and near round in popcorn to a half inch long and a flattened cylinder shape in some other kinds. The kernel consists of the following: (1) An outer thin covering which is

Crop	General Information and Cultural Practices
	made up of two layers, an outer pericarp and an inner testa or true seed coat. (2) The endosperm which makes up near 2/3 of the total volume. This consists almost entirely of starch, except in sweet corn. (3) The embryo, the miniature plant structure that develops into a new plant if the seed is planted and grows. The embryo is near one side of the kernel in most kinds rather than in the middle. It contains most of the oil in corn. The oil is obtained from the germ of the corn seed. In the preparation of certain corn products, as hominy, starch, glucose, the germ is separated from the rest of the seed mechanically. The germ contains near 50% of oil, which is separated with of corn expellers or with solvents. About a half pound of oil is obtained from a bushel of corn. Most of the oil is used as a salad or cooking oil or in the manufacture of lard substitutes. There is some use in industry. Three major types of corn are grown in the United States: **Grain or field corn** is grown annually for grain and silage. **Sweet corn** is used mainly as food and is distinguished from field corn by the high sugar content of the kernels at the early "dough" stage, and by wrinkled, translucent kernels when dry. The plant is a single stemmed annual, grown from one seed, though sucker shoots rise from the base. The stem produces 1 to 3 ears, each consisting of a base or cob on which the seed is embedded and completely encased in several layers of thin, papery husks. Plants attain a height up to 6 to 8 feet, with grass-like leaves up to 2 feet long and 2 inches wide. For food, sweet corn must be harvested when kernels are fully developed, but still in an immature or "dough" stage, otherwise they lose sweetness and become tough. **Popcorn** is used mainly for food. Popcorn is characterized by a very high proportion of hard starch. Under heat the moisture in the starch grains expands rapidly resulting in an explosive rupture of the epidermis and the starch grains. Increase in volume after "popping" is 15 - 35-fold, depending on variety. Insufficient moisture in the kernels results in poor popping. Both the plant and ears of popcorn are smaller than the grain corns but are otherwise similar. Grain corn is further classified commercially into four main types: **(1) Dent corn**, when fully ripe, has a pronounced depression or dent at the crown of the kernels. The kernels contain a hard form of starch at the sides and a soft type in the center. This latter starch shrinks as the kernel dries. Dent varieties vary in kernel shape from long and narrow to wide and shallow. It is the type mainly grown in this country. (2) **Flint corn** has the hard starch layer surrounding the outer part of the kernel. Consequently, on drying the kernels shrink uniformly and do not develop a depressed area and are around in shape.

Crop	General Information and Cultural Practices
	(3) Flour or soft corn kernels contain almost entirely soft starch, with only a very thin layer of hard starch. This type is little grown commercially. **(4) Waxy corn** is so-called because the endosperm when cut or broken is wax-like in appearance. The starch consists almost entirely of amylopectin, while in ordinary corn the starch is nearer 30% amylose and the remaining 70% is amylopectin. Waxy corn is largely used industrially although it is also suitable for food or feed. Acreage of waxy corn is small as compared with dent or flint. **Pod corn** is a curiosity in which each individual kernel is covered by a pod-like growth in addition to the husks enclosing the ear. It is not grown commercially. Nearly all the corn now grown in the United States is of hybrid varieties. Seed is obtained by crossing inbred lines which are obtained by self-pollination through several generations. This results in reduced vigor and yield but increased uniformity in the inbreds. To produce hybrid seed, two inbreds are planted together and the tassels removed from one before any pollen is shed. Thus, kernels on the detasselled variety are from pollen produced on the other inbred line. This restores and increases vigor and is known as a single cross. Two single crosses may be similarly crossed producing what is termed double cross seed. Properly selected and adapted hybrid corn varieties produce higher yields and more uniform plants and ears than the open pollinated varieties formerly used. About 75% of the grain corn produced in the United States is fed to livestock. In hog feeding, whole ears may be used. For other livestock and poultry, and some hog feeding, kernels are removed from the cob by machinery and are often partially ground before feeding. About half of the feeding is done on the farms where the corn is produced. Over 10% of grain corn grown in the United States is exported either as grain or corn products. From 12 - 15% of the crop is processed for starch, corn sugar, syrup, corn oil, corn-oil meal, gluten feed and meal, whiskey, alcohol, and for direct human food in the form of corn flakes, corn meal, hominy and grits. For silage, the corn seed is planted more closely spaced than for grain to obtain maximum yields. The corn is harvested before the kernels ripen from the late dough to early dent stage. At this stage the plant is still green and somewhat succulent. The whole plant is cut near the ground and passed through silage cutters either in the field or at the silo or pit. Thus, silage is a mixture of all the above-ground plant parts. Corn silage is mainly used for feeding cattle, especially dairy cows. Corn stover is mature dried stalks from which the whole ear is removed. There is strong evidence that teosinte is the wild ancestor of corn and not wild pod corn. Teosinte originated in Mexico. 'Chulo' is a corn cultivar released by USDA-

Crop	General Information and Cultural Practices
	ARS in Puerto Rico that can be grown year around in the Tropics. Makes good poultry feed because of its smaller size kernels. Some popcorn cultivars are grown for baby corn. Baby corn production is similar t sweet corn. Ears are normally 10 cm long and 1.2 cm in diameter.
Cram-cram	Cram-cram is found throughout tropical Africa, extending eastwards through Arabia and Iran to Pakistan and India. It has been introduced elsewhere, e.g. in North America and Australia. The grain of is edible and highly nutritious. Loosely tufted, annual grass, with ascending stems (culms) up to 1 m tall. Leaves alternate, simple and entire; ligule a line of hairs; blade linear, flat, apex filiform. Inflorescence a spike-like panicle 2 – 15 cm × 9 – 12 mm, with 1 – 3 spikelets enclosed by an involucre of prickly bristles. Spikelet lanceolate 3.5 – 6 mm long, acute, consisting of 2 glumes and usually 2 florets; glumes shorter than spikelet. Fruit a dorsally compressed caryopsis (grain), 2 – 2.5 mm × 1.5 – 2 mm. Cram-cram comprises about 20 species in tropical and warm temperate regions, mainly in Africa and the Americas. It is closely related to *Pennisetum*, which differs in non-spiny inner involucral bristles free to the base. The spiny spikelets of Cram-cram adhere to hairs of animals and clothes, making possible wide dispersal. Cram-cram follows the C4 cycle photosynthetic pathway.
Fonio	An erect, free-tillering grass and cereal crop reaching a height of about 45 cm. It is also called hungry rice and is considered native of West Africa, and is grown throughout the Savanna areas from Senegal to Cameroun. Yields vary from 150 - 800 kg/ha, but over 1 t/ha have been recorded.
Huauzontle, grain	Huauzontle is one of four plants that were domesticated in the eastern woodlands of North America prior to the introduction and wide utilization of corn. It was grown in Mexico, and is now grown commercially for its colorful (green and red) leafy foliage. Served in salads at restaurants, it now goes by the moniker, Red Aztec Spinach. The Aztec utilized different cultivars of this plant for the greens and the abundant small fruits that were produced on tall flower stalks.
Job's tears	An annual, 1 - 2 m tall, stem erect, with brace-roots from the lower nodes. Inflorescences prolific; the first glume of the male spikelet narrowly winged, the wings not covering the raceme. Seeds yellow, purple, white or brown. The grass is monoecious with separate male and female flowers. There are soft-shelled forms for eating and hard-shelled ones for ornamentation.
Millet, finger	Millet finger is a tufted annual grass that grows to 210 - 620 mm tall. The leaf blades are shiny, strongly keeled and difficult to break and are 220 - 500 mm long and 6 - 10 mm wide. The leaves and culms are typically green in color. It has a strong root system and it

Crop	General Information and Cultural Practices
	is difficult to pull out of the ground by hand. The spikelets do not disarticulate at maturity. There are two subspecies of African finger millet, the wild form (*E. coracana* subsp. *africana*) and a cultivated form derived from it (*E. coracana* subsp *coracana*). Wild African finger millet (*E. coracana* subsp. *africana*) is like Indian goosegrass (*E. indica*) and may be confused with it, but the latter has smaller spikelets and oblong, not rounded, grains. The grains of *Eleusine* are unusual in that the outer layer (pericarp) is not fused and can be easily removed from the seed coat.
Millet, foxtail	This warm season annual grass was cultivated in China more than 4,000 years ago. It was introduced into this country from Europe in 1849 and is now grown through the Plains and Central States north from Texas. It is used as hay, pasture and green fodder. The seed is used as bird feed. Foxtail millet is an annual grass growing 3 - 5 feet under the best conditions. It is a warm weather crop, usually seeded after the soil becomes warm in late spring. Flowering stems are leafy throughout their length, but the hay or fodder is less nutritious than several other grasses and legumes. For this reason, it is now grown less than in the past. Several varieties, differing slightly in characteristics, are available. A weedy grass called foxtail is a close relative.
Millet, pearl	Pearl millet is one of five millet species of commercial importance, the others are proso, foxtail, Japanese and browntop. Pearl millet is native to India but came to the United States via the West Indies. It is a tall upright annual grass, up to 10 feet, with coarse stems which grow in dense clumps. Leaves are coarse, 2 - 3 feet long and an inch wide and numerous. In fertile soil, it produces great amounts of green fodder, which is palatable and nutritious, and can be cut repeatedly during a season. It is grown both for pasture and silage. It can be grown as far north as Maryland, but is better farther south. The seed is planted directly in the field, generally in rows about 4 feet apart. Pearl millet is also a food grain crop. It was introduced into the U.S. but seldom grown until 1875. It is primarily grown in southern U.S. as a temporary pasture. Millets are annual grasses that have seedbed preparation like spring seeded small grains. Outside the U.S., more than 95% of the pearl millet crop is grown for grain. While the U.S. regards it as a high yielding summer annual forage crop. Excellent dry season grass for beef cattle. Also, there are up to 3 cuttings per season at 6 - 7 week intervals for hay, silage or greenchop.
Millet, proso	Proso millet is the only millet grown as a grain crop in the United States. Other millets, as foxtail, Japanese or barnyard, and pearl millet or cattail are grown mainly for forage or pasture. Proso millet is probably grown on not more than 150,000 acres in the United States. Most production is in the Northern Plains and other short-

Crop	General Information and Cultural Practices
	growing season areas. In Asia, Africa and Russia, grain millet is an important food crop, but is less important than formerly as other adapted grains are more desirable. Since proso millet will mature a grain crop in from 50 - 75 days after seeding, and is low in moisture requirement, it will produce some food or feed where other grain crops would fail. Millets have been grown in Asia and North Africa since prehistoric times, and little is known of their origin. They probably came originally from Eastern or Central Asia. They were important in Europe during the middle ages before corn and potatoes were known there. Today they are of minor importance in Western Europe. Proso millet grows up to four feet with stout, erect stems which may spread at the base. The panicle or flower head is rather open, like oats, and drooping. The flower consists of the lemma and palea, enclosing the stamens and pistil. As in oats, the lemma and palea adhere to and are a part of the threshed grain. The ripened seed is small (about 2 mm. wide and 2.5 mm. long), ovate and rounded on the dorsal side. Seeds range in color from white or cream to yellow, brown or nearly black. The seeds do not mature uniformly and shattering of those first ripe often occurs before others are mature. For this reason, the crop is usually mowed and cured in the windrow prior to combining. As food in Old World countries, millet is used as a meal for making baked foods, as a paste from pounded wet seeds or as boiled gruel. As feed the grain is eaten readily by livestock, and is equal to or superior to oats in feed value. It should be ground for livestock feed. It is also used in poultry and bird seed mixes. A related species is browntop millet *Urochloa ramosa* (L.) T.Q. Nguyen, which is sometimes seeded for game bird pasturage in the southeastern states.
Oat	Oats are one of the top 5 grain crops in the United States. They are grown to some extent in most continental states. Most oats are used for livestock feed. About 23% of the total production in this country is used as food, mainly in the form of breakfast food, oat bran and oat flour. Some acreage is also used for pasture, hay, green chop and silage. Spring oats are less likely to be grown for forage than winter oats. Oats are believed to be mainly Asiatic in origin. Different kinds of oats probably came from different parts of that continent or Europe. As a cultivated crop, oats appear to be substantially later in origin than wheat. Early use of oats appears to have been medicinal. Cultivation of oats was extensive in Europe prior to the discovery of America, and the earliest settlers brought seed to the new world. They are now an important crop in all temperate zone countries. The oat plant, like wheat, is an annual grass with kinds and varieties adapted either to fall planting and midsummer harvest or spring planting and late summer harvest. In general, overwintering kinds are grown where winter climates are mild, as throughout the Cotton

Crop	General Information and Cultural Practices
	Belt and in the western portions of the Pacific States. Spring seeding is generally practiced in other areas. The early growth of the plant consists of leaves and a greatly shortened stem, giving a rosette type of plant. The early habit may be prostrate, semi-prostrate or upright. Tiller or branch buds under the soil surface grow into additional "branch plants" or tillers. The number of tillers formed depends on density of seeding, variety and growing conditions. In general, varieties adapted for spring planting form relatively few tillers, while up to 30 tillers may form on fall varieties under favorable conditions. However, all may not produce panicles. With fall seeding, plants generally remain in the rosette stage until spring. With spring seeding this stage is relatively short. The main stem and tiller stems then push upward reaching to 2 or more feet, again depending on variety and growing condition. These stems terminate in a large, generally loose panicle on which the flowers and seeds or kernels are borne. The panicle consists of a central stem or rachis, side or rachis branches which rise in whorls at the nodes, and spikelets in which the flowers and seeds are borne. Each main and lateral stem or rachis terminates in a spikelet, but spikelets also are produced at the nodes of the branch stems. The panicles may be spreading in equilateral fashion, or one-sided. From 20 - 150 spikelets may be produced on one panicle. Spikelets often droop or hang downward but may be upright. The spikelets are subtended by two loose membranous glumes, which generally are longer than the spikelet and largely cover it during flower and seed development. These are removed in threshing. In hulled varieties, the spikelets usually contain three florets or flowers, one of which is rudimentary and nonfunctional. Generally, two kernels or seeds are produced per spikelet, but sometimes only one develops. In so-called naked oats 3 to 1 flowers may be produced per spikelet. The palea may be awned or awnless and it and the lemma enclose and adhere to the developing ovary or seed, except in so-called hull-less oats. Thus, they are a part of the seed following threshing in most kinds. The oat kernel, also termed caryopsis or groat, is the part remaining after removal of the palea and lemma. The oat kernel consists of 25 - 41% pericarp, 55 - 70% endosperm and 2 - 4% germ. When used for feed, the whole oat as it comes from the thresher, which include the palea and lemma but not the glumes, is fed either whole or after grinding. In products used for food the lemma and palea are also removed.
Oat, Abyssinian	It is adapted to high elevations and seldom grown alone, usually grown with barley. Stems are erect 40 - 90 cm tall, rather small and stiff. Panicles are equilateral, medium sized, very drooping. This species is grown to some extent in Ethiopia but not in the United States. It is often considered a weedy species.

Crop	General Information and Cultural Practices
Oat common	This is the most important of the cultivated oats. Magness et al noted 146 varieties of common oats, most of which were grown commercially in some part of the United States although production of many of them was very limited. Numerous new varieties have been released since that time, while a good many he listed are no longer grown. Included are many varieties of winter and of spring habit. The plants of different varieties differ in vigor and height. Everyone are characterized by a panicle that is roughly pyramidal in shape with equilateral branches that spread outward. Many varieties are awnless, and in awned varieties, usually only the first flower is awned. Lemmas and paleas adhere to the kernel and may be white, gray, yellow or black in color. Shape and size of grains also are highly variable. Basal hairs are few, under the lemma. Several important cultivated varieties of both winter and spring habit are included in this species. Red oat varieties are the kinds generally grown in the southern half of the United States. Presently, red oats are the same species as common oats. Side oats is of much less economic importance in the United States than the common or tree oat since varieties of it are generally lower yielding. All the side oat varieties are of spring type. The principal distinguishing characteristic of this subspecies is the panicle which is almost entirely at one side of the stem axis. Side branches on the panicle arise from all sides of the stem, but branches turn to one side of the stem or rachis. They also tend to turn upward more than in common oats. Like in the common oat, lemmas and paleas adhere to the kernel and may be black, gray, yellow or white in color.
Oat, naked	This species the kernel or caryopsis is loose within the palea as in the major kinds of wheat. The stems grow erect to 60 - 80 cm tall. The origin of the species appears to have been Central and Eastern Asia. Several varieties have been introduced or have been developed in this country, but they are grown only to a very limited extent.
Oat, sand	Sand oat has lemmas are lance-like, extending to two distinct points. The plant has small, erect stems that vary widely in height from 80 - 200 cm. Panicles are near equilateral. The species is widely distributed in Europe and has become naturalized in California. It is not grown as a grain crop.
Psyllium	Annual herbaceous plants to 18 inches tall cultivated for its seed which is used for its mucilage content. The mucilage layer (husk) is the outer seed layer which accounts for about 25% of the total weight of the seed. The mucilage is obtained by mechanical grinding of the outer seed layer. It is a true dietary fiber in diets, medicines, and cereals. As a thickener, it is used in ice cream and frozen desserts. Seed kernel is grown and fed to cattle and horses. Its primary use is for the husk as a dietary fiber for humans.

Crop	General Information and Cultural Practices
	Psyllium is the common name used for several members of the plant genus *Plantago* and the genus contains over 200 species. The U.S. is the world's largest importer with over 50% of the total imports to pharmaceutical companies (about 8,800 T/A/per year). The seed mucilage is referred to as husk or psyllium husk. In India, the dehusked seed is used for chicken and cattle feed.
Quinoa	Staple ancient Incas grain rich in protein. Annual herb, 1½ - 6½ feet tall, is native to the Andes Mountains. Quinoa means "mother grain" in the Inca language. Quinoa is a pseudocereal like buckwheat and amaranth. The seed coats are covered with bitter saponin compounds that must be removed before human consumption. Some varieties have low levels of saponin and are referred to as "sweet varieties". Quinoa has a thick, erect stalk that made be branched or unbranched and the leaves on young plants are green.
Rice	Rice is the principal food crop in practically all the tropical regions of the world as well as in most subtropical areas and in some temperate zone areas having a relatively long growing season. Probably half of the world population depends on rice for its major food source. Rice has been cultivated since antiquity. Seeding of rice was a religious rite in China nearly 5,000 years ago. The cultivated plant probably originated in Southeast Asia where wild types persist. Rice cultivation in Europe began around 700 A.D. Rice was brought to America by the earliest colonists. All rice grown in the United States and most of that cultivated in other countries is of the species *Oryza sativa* L. This is a cultivar species, not found in the wild. Some 20 - 25 species of *Oryza* are known, but the ancestry of the cultivated types is uncertain. The species O. *glaberrima* Steud. is cultivated in Africa. More than 8,000 variety names for rice are known, but many of these may be local names given to similar or identical varieties. However, many hundreds of varieties distinct in characteristics or in adaptation are known. These are roughly classed in three groups as follows: (1) **Japonica Group**. In general, varieties in this group have short kernels. Stems are stiff, short and upright. Leaves are short, dark green and the second leaf forms a narrow angle with the stem. Plants are pubescent and form many tillers. Panicles are numerous, short, dense and heavy. Spikelets are awnless. This group is generally grown in more northern climates as Japan, Korea, Northern China, Europe, and California and Arkansas in this country (short grain). (2) **Indica Group**. This group is more tropical in adaptation than Japonica varieties and includes the kinds grown in Southern Asia, the Philippines, and the South-Central States and California in this country. These varieties are

Crop	General Information and Cultural Practices
	characterized by long kernels, long, light green leaves, tall, somewhat spreading stems, much less stiff than stems in Japonica varieties and tend to lodge. Panicles are numerous, long, light in weight, medium in density. Spikelets are awnless (long grain). (3) **Bulu or Javanica Group.** This group is of minor importance compared with Japonica and Indica. Varieties classed here are grown mainly on the islands off Southeast Asia. In the U.S., medium grain rice is grown in Arkansas, California, Louisiana, Missouri, and Texas. They are somewhat intermediate in characteristics. The kernels are large, stems are tall, stiff and upright. Panicles are few, of medium length and density, but heavy. Awns are numerous (medium grain). Rice Culture The rice plant differs from most grains in that it thrives best when grown with the soil surface covered with water. Some rice is grown on soils that are not flooded, but soils well supplied with moisture are necessary and even then, yields are much less than with flooded rice. This so-called “upland" rice is not grown in this country. Upland or dryland rice is direct seeded in a dry seedbed and grows to maturity without natural or artificial, prolonged flooding conditions. It is generally restricted to tropical areas. Lowland or wet paddy rice is grown in the U.S. It grows under artificial flood that may be continuous from seeding until drained for harvest. In Arkansas, long grain types mature in about 110 - 130 days, while medium grain types mature in 135 days. These grains are flooded 66 - 90 days during the heading period. Some crop rotations for rice include oat, lespedeza, soybean, fish, and grain sorghum. Rice seed requires a high soil moisture content to germinate. It germinates and grows readily when seeded on the soil surface under water. Much of the seeding in this country is on flooded sites, the seed being spread from airplanes. It may also be drilled in prepared soil, followed by flooding after growth starts. In Oriental countries where land is scarce, rice is often started in nurseries and transplanted to the field. This is economical of land use but does not result in higher yields than seeding in place. For highest yields, fields are kept flooded from time of seeding or transplanting until shortly before harvest, with water 4 - 8 inches deep. Water should not become stagnant. If possible, a slow inflow and outflow of water should be maintained. An alternative practice is to draw off the old water and flood with fresh water at intervals. In the United States, nearly all rice is harvested with combines. Water is withdrawn 2 - 3 weeks before harvest to dry the soil enough for combine operation. Rice so harvested generally contains too much moisture to keep in storage

Crop	General Information and Cultural Practices
	and must be dried artificially prior to storage. An alternative method, no longer used in this country, is to mow the rice and let it lie in swaths to dry prior to threshing. Some modification of this method is widely used in most countries where rice is grown. In very humid climates the mowed rice may need to be removed from the field and kept off the ground to permit drying prior to threshing. Rice is cultivated as an annual although plants will persist for more than one season through rooting of tillers, in areas where freezing does not occur. Whether under water or in moist soil the central stem first emerges. Within a few days' tiller or branch plants grow from buds in leaf axils near the soil level. The number of such tillers varies with the density of the plant stand and with the variety. Usually not more than half a dozen stems develop from a single seed, but up to 50 tillers may form on some kinds if very widely spaced. Only tillers that form early produce panicles and ripen grain. Stem height ranges from less than 20 inches to 6 feet or more. Stems are hollow between nodes. Tall growing kinds are subject to lodging or falling over, particularly if fertilized. The shorter-and stiffer-stemmed varieties are therefore more satisfactory as use of fertilizers generally results in greatly increased yields. Recent development of short, stiff-stemmed varieties adapted to the tropics, coupled with the increased use of fertilizer possible on such varieties, is resulting in greatly increased production in South Asian Countries. The panicle or seed-bearing head roughly resembles that of oats but is more compact and tends to droop more. The panicle is usually 4 - 10 inches long with branches that rise singly or in whorls. Each branch bears several spikelets, each with a single flower. The panicles usually contain from 75 - 150 spikelets, but the number may be greater. The panicle is initially enclosed in a sheath. It emerges from the sheath about 75 - 80 days after seeding in the earliest varieties and in 125 - 130 days in late varieties. The period from panicle emergence to full seed ripeness is about 35 days. The flower in rice consists of two small, sterile lemmas which partially cover the developing seed, floral bracts, the lemma and palea, and within these the stamens and pistil, or sex organs. As in most oat and barley varieties, the lemma and palea adhere to the developing seed or kernel. The lemma may be awned but is awnless, or near awnless, in most cultivated varieties. The adhering lemma and palea constitute the "hull" of the threshed grain or so-called "rough" rice. After the hull is removed in milling the rice is termed "brown" or "hulled." The hull comprises about 20% of the kernel weight. Further milling removes the bran (5 - 8%), or seed coat, the germ (4%), and some of the endosperm (68%). This results in about an additional 10% removal by weight.
Rice, African	African rice has small grains that are pear-shaped and have a red

Crop	General Information and Cultural Practices
	bran and an olive-to-black seed coat, straight panicles that are simply branched, and short, rounded ligules. However, some Asian rice types also have pear-shaped grains with a red bran, and some African types have pointed ligules. Plants have luxurious wide leaves that shade out weeds and the species is more resistant than its Asian cousin to diseases and pests. Moreover, African rice is better at tolerating fluctuations in water depth, iron toxicity, infertile soils, severe climates, and human neglect. Some *O. glaberrima* types also mature faster than Asian types, making them important as emergency food.
Rye	Much of the rye produced in the United States is used for hay, silage, pasture, erosion control or plowed under for soil improvement, with only approximately 1/3 of the acreage harvested for grain. Most of the rye for grain is produced in the Southern and Central States. The rye plant grows rapidly and vigorously from seed, resulting in a rapid cover valuable for erosion control or early pasture. Selected varieties are hardier to cold than other cereal grains, so rye as a winter crop can be grown in areas too cold for winter wheat. Also, rye will produce better on light, sandy soils and on soils of low fertility than other small grains. Because rye develops rapidly, especially in early spring, it can be plowed in early and still give a good volume of organic matter for soil improvement. Rye as pasture or hay is less palatable than other small grains or legumes but is readily grazed if other grazing is not available. Rye as a grain crop is similar in most respects to wheat. Practically all the rye for grain is sown in the fall and harvested in early summer. It is earlier maturing than wheat. Stems reach 3 - 5 feet in height. The spikes are 3 - 5 inches long, slender and awned. Seeds are enclosed in the palea and lemma, as in wheat, but tend to protrude when near ripe, so are less completely enclosed than in wheat. The seed threshes free of the palea and lemma. The seeds tend to shatter or fall out when ripe. For this reason, coupled with earlier ripening, rye may be a bad weed in wheat fields. In the Midwest, rye is primarily grown for grain and occasionally for hay or pasture. Rye makes excellent forage, especially when combined with red or crimson clovers and ryegrass. Rye fits into crop rotations and can be grazed followed by warm season crops, such as corn, sorghum and an oilseed crop. The rye kernel is composed of 12 - 17% pericarp, 80 - 85% endosperm, and 2 - 4% germ. About 125 pounds of rye grain gives a milling yield of 100 pounds of rye flour. Rye is second only to wheat for flour production. Milling of rye is essentially like wheat. Baked goods made with rye flour have a distinctive flavor. As feed, rye is not relished by livestock, so rye grain is usually fed in mixtures with other cereals. In nutritive value rye is a little lower than wheat. Substantial quantities of rye are also

Crop	General Information and Cultural Practices
	used for making distilled alcoholic beverages.
Sorghum, grain	Grain sorghum in the United States is grown mainly in the Central and Southern Plains States. In the United States, most of the grain sorghum is used as livestock feed, but in the Orient and Africa most is used as food. Sorghum culture goes back to antiquity with Egypt being an early area. Grain sorghums grown in this country mainly trace to African origins. Although they were brought here during early colonial days they did not become important crops until farming developed in drier sections of the United States. They generally out yielded other grains under conditions of limited moisture. Grain sorghum plants are coarse annual grasses. Nearly all the varieties grown in the United States are so-called dwarf types, with stems under 5 feet in height and suitable for harvesting with combines. In other counties, many taller-stemmed kinds are grown. Leaves are relatively broad, have numerous but small stomata, and are covered with a waxy bloom. They tend to roll along the midrib under moisture stress. Thus, the plant is more drought resistant than most other grains and requires less water per pound of dry matter produced. Flowers and seeds are borne in relatively dense panicles that vary from 3 - 20 inches in length and up to 3 inches in width. The panicle is enclosed in a rather strong sheath until just before the first flowers open. Branch stems in the panicle rise in whorls and may be few or many. They are also variable in length, resulting in variable density of the panicle. Spikelets are partially enclosed in two rather short, thick glumes. Each spikelet contains two flowers, only one of which is usually fertile and sets a seed. The fertile flower consists of a thin lemma and thin palea, and inside these the stamens and pistil, the latter developing into the kernel. The lemma may be awned or awnless. When threshed the seed separates from the floral bracts as in wheat. The kernels are small, averaging about 2/3 the weight of wheat grains. Weight of 1000 sorghum grains is mostly between 20 - 30 grams. Kernels are generally near round to broad-conic in shape. The grain consists of about 6 percent bran, the pericarp or surface lavers, 10% germ, and 84% endosperm, which is largely starch. In protein content, sorghum is higher than corn and about equal to wheat. In fat content, it is lower than corn but higher than wheat. Grain Sorghum Groups: Grain sorghum varieties are classed in seven agronomic groups, as follows: (1) **Kafir sorghum**, originally from South Africa, have thick, juicy stems, large leaves, and awnless cylindrical-shaped panicles. Seeds may be white, pink or red and are medium in size.

Crop	General Information and Cultural Practices
	(2) **Milo sorghum**, originally from East Africa, have stems that are less juicy than in Kafir. Leaf blades are wavy with a yellow midrib. Heads are bearded or awned, compact, oval. Seeds are large, pale pink to cream in color. Plants tend to be more tolerant to heat and drought than the Kafirs. (3) **Feterita sorghum**, came from Sudan. Leaves are sparse in number. Stems are slender and dry. Panicles are compact and oval. Seeds are very large for sorghum, chalky white in color. (4) **Durra sorghum**, are from the Mediterranean Area, the Near East, and Middle East. Stems are dry. Panicles are bearded and hairy and may be compact or open. Seeds are large and flattened. (5) **Shallu sorghum**, from India have tall, slender, dry stems. Heads are loose. Seeds are pearly white in color and late maturing, thus requiring a relatively long growing season. (6) **Koaliang sorghum**, typical of those mainly grown in China, Manchuria and Japan, have slender, dry, woody stems with sparse leaves. Panicles are wiry and semi-compact. Seeds are brown and bitter in taste. (7) **Hegari sorghum**, from Sudan are somewhat like Kafirs but have more nearly oval panicles, and plants that tiller profusely. Seeds are chalky white. In the United States, most varieties have been derived from crosses involving Kafir and Milo. Other groups have also entered some varieties, so the varieties now grown are generally not typical of any specific group. White sorghum without tannins is preferred for human food. Most sorghums now being grown in this country are from hybrid seeds, made possible by the finding and isolation of male sterile strains. When the male-sterile line is planted alongside suitable lines with fertile pollen all the seed produced on the male-sterile line is hybrid. Like the forage sorghums, the green grain sorghum plants contain the glucoside dhurrin, which converts to prussic acid (HCN) and is poisonous to livestock. For this reason, grain sorghums are not suitable for pasturage. .
Teff	Teff is a staple cereal grain crop of Ethiopia. The plant is a slender upright tufted annual that is drought resistant. It has a brown panicle with red, white or brown seed with yields averaging 0.9 tons/ha and improved cultivars at 1.7 - 2.25 tons/ha. Hay yields are 3200 t-6000 lb/A. Teff is an intermediate grass between tropical and temperate grasses. It provides greater than 2/3 of the human nutrition in Ethiopia. In the U.S., teff is considered a health food. The grain contains no gluten.

Crop	General Information and Cultural Practices
Triticale	Triticale is a small grain cross between wheat and rye. It is the first man-made commercial crop. It has the advantage of out yielding wheat and rye in many marginal crop production areas. The grain is mainly used for feed and the foliage as a forage crop. The grain is also used in bread, noodles, cakes, and crackers. There are both spring and winter varieties. It has major developmental programs in Canada and Mexico. The lemma and palea thresh free from the grain. The grain weighs 45 - 50 pounds per bushel.
Wheat	Wheat is the most important food grain of the temperate zones. Wheat has been a food crop for mankind since the beginning of agriculture. Wheat is essentially a cool season crop that thrives best at preharvest temperatures averaging around 60F. The minimum frost-free growing season is about 100 days. In continental United States wheat is grown in every state although production in New England is minor. From 15 - 20 or more inches of precipitation are necessary for annual cropping. In some areas with not more than 10 - 15 inches of precipitation the wheat is grown once in 2 years, with the land kept free of vegetation one of the years to accumulate moisture in the soil. The wheat plant is an annual grass. It is mainly grown as a winter annual in milder climates, with seeding in the fall and harvest from June through August depending on the length of the winter. In areas with rigorous winter climates it is mainly spring seeded. Planting is as early as soil can be worked, and harvest is in late summer and early fall. Winter wheat is seeded in dryland areas at 60 - 120 lbs/acre, irrigated areas 60 - 150 lbs/acre, and for grazing at 75 - 120 lbs/acre. In early growth stages the wheat plant consists of a much-compressed stem or crown and numerous narrowly linear or linear-lanceolate leaves. Leaves are mainly near glabrous. Buds in the leaf axils below the soil surface grow into lateral branches termed tillers. From both the main crown and the tillers, elongated stems develop later and terminate in a spike or head in which the flowers, and finally the seed or grain, develop. In fall-seeded wheat the plant usually remains in the rosette stage throughout the fall and winter, sending up the elongated stems in late spring. In spring-seeded wheat the rosette period may be short, and tillering is usually much less than in fall plantings. During late fall and early spring, fall-seeded wheat can be lightly pastured without greatly reducing grain yields, and this is frequently done. The pasturage at this stage is nutritious and highly palatable. Stems of wheat reach from 18 inches to 4 or more feet in height depending on kind and growing conditions. The spike or head may be from less than 2 inches to 4 or 5 inches long. Both stems and spikes from the latest-formed tillers are usually somewhat smaller than those of the early formed tillers. Spikelets develop at nodes in the spike and in these spikelets the flowers and seeds develop. Density of spikelets and overall shape of

Crop	General Information and Cultural Practices
	the spike also vary. The flower consists of two outer membranous tissues, one termed lemma and one palea, which enclose the stamens and the single ovary which develops into the seed or kernel. Together these are termed the glumes, and they continue to enclose and completely cover the developing seed. In awned varieties, the awns or beards are at the terminal of the lemma. The palea is membranous and awnless. In most wheats, the lemmas and paleas are separated from the kernels in threshing, forming the chaff. In spelt and emmer, formerly grown to a very limited extent for feed in this country, they continue to adhere to the seed following threshing. The wheat grain or kernel is roughly ovate or egg shaped and from 1/6 - 2/5 inch in length depending on kind. The dorsal surface is generally smooth and rounded but the ventral surface is creased. At the apex, a brush consisting of short hairs is generally present. Color of the kernel varies from dark red through light brown, - classed commercially as red wheat, to white, cream or yellow, - classed commercially as white wheat, or amber, in durum wheat. The wheat kernel is made up of three main parts: (1) The outer covering consists of several distinct cell layers and is the bran, separated from the flour during most milling processes. It comprises about 12% of the kernel weight. (2) The endosperm consists mainly of starch and makes up about 85 – 86% of the kernel. It is the portion present in white flour. (3) The germ, or embryo, expands into the new plant at and following germination. It makes up only about 2.5 percent of the kernel and is also separated out in most milling processes, and the bran layer is 3 - 4 percent. Botanical Classification of Wheat In U.S. Dept. of Agr. Technical Bulletin 1287, titled "Classification of *Triticum* species and Wheat Varieties Grown in the United States", wheat is classified into 10 species of *Triticum*. Six of these are cultivated and four are non-cultivated, or rarely so. Winter wheat includes hard red, soft red and white. Spring wheat includes hard red, durum and white. Wheats are classified as "hard" or "soft" depending upon the endosperm granularity. Hard wheats have flinty, translucent grains while soft wheats have starchy, opaque looking grain.
Wheat, club	Cultivars of club wheat may be either of winter or of spring type. Stems vary in height but are generally stiff. Spikes are short, usually < 2.5 inches in length, very compact and flattened. Spikelets usually contain 5 flowers and spread at near right angles to the rachis or stem. Spikelets are generally awnless, but sometimes awned. Kernels are small, flattened, have a very shallow, narrow crease, and a short brush. Principal use for club wheat is for flour manufacture for crackers, cookies and cakes.
Wheat, common	This species has a long, slender spike which is somewhat flattened.

Crop	General Information and Cultural Practices
	Spikelets are 2 - 5 flowered, relatively far apart on the stem and nearly erect. Awns are either lacking or less than half an inch long. Stem centers are generally hollow but may be pithy. Leaves are more narrow than in some other wheats. Kernels may be red or white, hard or soft and the grain threshes free of glumes. This is the source of most of the wheat varieties cultivated in the United States. Over 200 such varieties have been described, with nearly 100 now cultivated. They may be either spring or winter type and comprise nearly 95% of the wheat grown in this country. Principal use is for flour for leavened breads and pastries.
Wheat, durum	Cultivars of durum wheat is grown in the United States are all spring wheats. Stems generally are pithy internally and leaves are relatively broad. Spikes are intermediate in length and flattened. Awns are nearly always present and are long and coarse, white, yellow or black in color. Kernels are white or red, usually long and pointed, very hard and translucent with angular sides and a short brush. Durum wheat is used mainly for the manufacture of semolina which is made into macaroni, spaghetti and related products. About 8 cultivars are grown in this country, mainly in North Dakota and neighboring states.
Wheat, einkorn	Einkorn or one-grained wheat is a primitive kind the cultivation of which goes back to prehistoric times. It is grown in isolated areas in the Middle East and southern Europe. It is used as flour for making dark breads and as cattle or horse feed. It is also finding a market as a health food. Both winter and spring forms occur. Spikes are awned, slender, narrow, flattened, and fragile. pale red, slender, flattened, almost without crease, and remain in the spikelets after threshing. Einkorn is little grown at present and not at all in the United States.
Wheat, emmer	Emmer is one of the most ancient of cultivated cereals. It was a major cereal until durum wheat was cultivated. In the last 40 years, its production has increased in Ethiopia and is sometimes ground for flour and baked into special bread and porridge. It may be either winter or spring in habit. Leaves generally are pubescent. Spikes are very dense and flattened laterally. Spikelets generally contain two flowers and generally are awned. The red or white kernels remain enclosed in the glumes after threshing. They are slender and acute at both ends. Emmer was formerly grown in the United States for feed on a limited acreage but now has substantially disappeared from cultivation.
Wheat, Macha	Macha wheat is a late-maturing winter wheat with tall, hollow stems. Spikes vary in density from open to dense, with short awns. Kernels remain in the spikelets after threshing. They are elliptical, red, and intermediate in hardness. Macha wheat is grown in the Republic of Georgia and southern Russia, but not commercially in

Crop	General Information and Cultural Practices
	the United States.
Wheat, Oriental	This is a spring wheat, early in maturity with narrow, pubescent leaves. Spikes are long, loose, and almost square in cross-section. Awns are long and often black. Spikelets produce 2 or 3 kernels which are long, narrow, white and hard. This wheat is grown in the Mediterranean Area and the Near East, but not in the United States.
Wheat, Persian	Persian wheat is of spring habit, early maturing, and somewhat resistant to fungus diseases. It has strong yellow to light red stems. Spikes are flexible, tending to lean over. While several flowers are present in each spikelet only three usually develop kernels. Kernels are free-threshing, flinty, almost always red. Persian wheat is grown in the Eastern Mediterranean Area, including southern Russia, but not commercially in the United States.
Wheat, Polish	Polish wheat varieties are spring wheats with tall stems. Spikes are large, up to 0.5 inches long, open or dense, awned, and square or rectangular in cross-section. Kernels are very long, narrow, and hard like rye. They thresh free of the glumes. While grown extensively in Mediterranean countries, Polish wheat has proved inferior in the United States both in yield and in quality for bread or macaroni products. For these reasons, it has substantially disappeared from commercial production.
Wheat, Poulard	Poulard wheats may be winter or spring in habit. Stems are usually tall, thick, and solid or pithy. Leaves are broad. Spikes are long and dense, sometimes compound or branched. They are near square in cross-section, with long awns. Kernels are short, ovate and humped in shape. Poulard wheat is closely related to durum but is somewhat inferior in this country both in production and in macaroni making quality, so has practically disappeared from cultivation. It is grown quite extensively in Mediterranean countries.
Wheat, shot	This is an early maturing spring wheat with short, stiff stems that tiller profusely. Spikes are awnless or short-awned and dense. They appear square in cross-section. Spikelets contain 6 or 7 flowers and develop 4 or 5 kernels. Kernels are short and almost spherical, unique among wheats, and thresh free and differ from other wheats by being shorter with smaller heads. Kernels are red or white in color. Shot wheat is grown in Northwest India, but not commercially in the United States.
Wheat, spelt	Spelt may be either winter or spring in habit and awned or awnless. The spike is long and narrow. Spikelets are two-kernelled and upright, closely pressed to the rachis or central stem. Kernels are red, long, flattened, with a sharp tip and a narrow, shallow crease. They remain enclosed in the glumes after threshing. Spelt has higher proteins and minerals than other wheats. Spelt flour has a nutty taste. Spelt has been grown in Europe over 300 years and introduced into the U.S. in 1890's. The spelt hull must be removed

Crop	General Information and Cultural Practices
	before it can be used for food. Hulls comprise 20 - 30% of the grain weight. Spelt can be used in flour and baked goods to replace soft red winter wheat. Spelt is more winter hardy than most soft red winter wheat but less than most hard red winter wheat. Spelt was formerly grown in the United States on a small acreage for livestock feed but has now almost disappeared from cultivation.
Wheat, Timopheevi	This is a late maturing spring wheat with leaf blades that are pubescent on both sides. Spikes are very compact, rather short, and somewhat pyramidal in shape with soft, thin, rather short awns. Spikelets usually contain two kernels. Kernels are medium long, slender and hard or flinty. The species occurs in the Republic of Georgia and southern Russia. It is not grown in the United States.
Wheat, Vavilovi	This a winter type wheat, mid-season in maturity with thick, strong, stems that resembles Spelt. Spikes are medium-dense and loose, and awned. Kernels remain in the spikelets after threshing. They are ovate, white and hard. This wheat is grown somewhat in Russia but not commercially in the United States
Wheat, wild einkorn	It grows as a native grass in the Balkans and Anatolia. Differs little from einkorn.
Wheat, wild emmer	This plant grows in the area from Israel to Russia. It grows in North and South Dakota. It is a winter annual with loose, flattened spikes hearing long, stiff awns. Spikelets fall from the fragile spike at maturity. Spikelets are large, usually with three flowers but developing only two kernels, wild emmer appears not to be cultivated. Kernels remain enclosed in the glumes after threshing and the grain is red or white in color.
Wheatgrass, intermediate	This is a perennial cool season sod-forming wheatgrass, introduced from Eurasia. It has proved well adapted to the Northern and Central Great Plains, and in the Pacific Northwest, as well as Canada. It is a little less hardy and drought resistant than crested wheatgrass. It is adapted to areas with rainfall > 350 mm and elevations up to 3000 m. It is suited to be grown with alfalfa under dryland conditions. Plant growth is vigorous, and is relished by all classes of livestock. Stems reach a height of 3 - 4 feet. For both pasture and hay production, this is a valuable grass for its area of adaptation, as well as good for soil erosion control. Forage quality declines rapidly at advanced stages of maturity. It is readily established by seeding, and is increasing in importance on marginal lands where orchardgrass and bromegrass are not well adapted. Often grown with alfalfa for hay or pasture in areas with a shortage of water. For seed production row spacing is 24 inches in irrigated areas and 36 inches in dryland areas with 25 - 30 seeds/linear foot. There are 79,000 seeds/lb. It reproduces by seed, tiller and rhizomes.
Wild rice	Wild rice is not closely related to cultivated rice, belonging to a

Crop	General Information and Cultural Practices
	different genus and even a different tribe of the grass family. The plants are native to North America, growing in shallow lakes and ponds from Southern Canada south to Florida. While much variation exists in size of plant, size of seed, and other characteristics in plants from different locations, all are included in *Z. aquatica* and *Z. palustris*. The plant is an aquatic annual grass with stems hollow except at the nodes. It grows only in water, preferably in lakes or ponds that are not stagnant yet have very little current. Growth is usually in water 3 feet or less in depth, with a mud bottom. Stems may reach 3 - 6 feet above the water surface and are terminated by large branched flower panicles. The basal part of the panicles bears only staminate flowers, while the terminal part bears only pistillate flowers and sets the seed crop. The seed is tightly enclosed in an outer palea and inner lemma. The lemma terminates in a stiff, twisted awn. In the wild, seed can be harvested from boats by bending the stems over the boat and beating the heads with a stick. In commercial production, harvesting machines are in use in which a reel-type beater is mounted on the front end of a flat boat. The harvested seed is enclosed in the palea and lemma and is quite moist. Seed does not mature uniformly and when mature drops into the water. Therefore, successive harvests are necessary to obtain a maximum yield from a location. Sufficient seed is always lost to maintain a stand under suitable growing conditions. The seed is composed of 14% hull, 77% endosperm, 4% pericarp and 4% embryo. Following harvest, the moist seed must be quickly dried to avoid spoilage. For food use it is dried by parching, which also loosens the hulls. Parching is done by heating in a rotating drum or in an open kettle with constant stirring to prevent burning. Hulls are separated from the grains by tramping or pounding in a pit and putting through a fanning mill or winnowing. The separated kernels are near cylindrical, 12 - 20 mm. long by 2 mm. or less in thickness. The seed is also an excellent wild life feed. While not a cultivated crop, favorable sites are often seeded in hunting preserves for wild life feed and for grain harvest. Around a million pounds of wild rice for food is harvested annually in North Central States and in Canada, much by Native Americans. Wild rice is unusually high in protein content and low in fat compared with other cereals. It normally sells at a price 2 to 3 times that of cultivated rice. Eastern wild rice is *Z. aquatica* which is not cultivated, while *Z. palustris* is cultivated. In 1963, a cultivar with reduced grain shattering was developed and allowed the use of harvesting equipment like cultivated rice. Cultivated wild rice is planted on dry ground and flooded to 6 inches with air seeding at 30 to 45 lbs per acre required the first year. The paddy will reseed itself and produce for 3 to 4 years in Minnesota. Fields are drained 3 weeks before harvest.

Crop	General Information and Cultural Practices
	Yields range from 50 - 1,750 lbs per acre. Approximately, 2.5 lbs of grain are processed into 1 lb of dry processed grain. Crop rotated with cultivated wild rice are buckwheat, rye, wheat, mustards, and forage grasses for seed production.
Wheatgrass, intermediate	This is a perennial cool season sod-forming wheatgrass, introduced from Eurasia. It has proved well adapted to the Northern and Central Great Plains, and in the Pacific Northwest, as well as Canada. It is a little less hardy and drought resistant than crested wheatgrass. It is adapted to areas with rainfall > 350 mm and elevations up to 3000 m. It is suited to be grown with alfalfa under dryland conditions. Plant growth is vigorous, and is relished by all classes of livestock. Stems reach a height of 3 - 4 feet. For both pasture and hay production, this is a valuable grass for its area of adaptation, as well as good for soil erosion control. Forage quality declines rapidly at advanced stages of maturity. It is readily established by seeding, and is increasing in importance on marginal lands where orchardgrass and bromegrass are not well adapted. Often grown with alfalfa for hay or pasture in areas with a shortage of water. For seed production row spacing is 24 inches in irrigated areas and 36 inches in dryland areas with 25 - 30 seeds/linear foot. There are 79,000 seeds/lb. It reproduces by seed, tiller and rhizomes.
Wild rice	Wild rice is not closely related to cultivated rice, belonging to a different genus and even a different tribe of the grass family. The plants are native to North America, growing in shallow lakes and ponds from Southern Canada south to Florida. While much variation exists in size of plant, size of seed, and other characteristics in plants from different locations, all are included in *Z. aquatica* and *Z. palustris*. The plant is an aquatic annual grass with stems hollow except at the nodes. It grows only in water, preferably in lakes or ponds that are not stagnant yet have very little current. Growth is usually in water 3 feet or less in depth, with a mud bottom. Stems may reach 3 - 6 feet above the water surface and are terminated by large branched flower panicles. The basal part of the panicles bears only staminate flowers, while the terminal part bears only pistillate flowers and sets the seed crop. The seed is tightly enclosed in an outer palea and inner lemma. The lemma terminates in a stiff, twisted awn. In the wild, seed can be harvested from boats by bending the stems over the boat and beating the heads with a stick. In commercial production, harvesting machines are in use in which a reel-type beater is mounted on the front end of a flat boat. The harvested seed is enclosed in the palea and lemma and is quite moist. Seed does not mature uniformly and when mature drops into the water. Therefore, successive harvests are necessary to obtain a maximum yield from a location. Sufficient seed is always

Crop	General Information and Cultural Practices
	lost to maintain a stand under suitable growing conditions. The seed is composed of 14% hull, 77% endosperm, 4% pericarp and 4% embryo. Following harvest, the moist seed must be quickly dried to avoid spoilage. For food use it is dried by parching, which also loosens the hulls. Parching is done by heating in a rotating drum or in an open kettle with constant stirring to prevent burning. Hulls are separated from the grains by tramping or pounding in a pit and putting through a fanning mill or winnowing. The separated kernels are near cylindrical, 12 - 20 mm. long by 2 mm. or less in thickness. The seed is also an excellent wild life feed. While not a cultivated crop, favorable sites are often seeded in hunting preserves for wild life feed and for grain harvest. Around a million pounds of wild rice for food is harvested annually in North Central States and in Canada, much by Native Americans. Wild rice is unusually high in protein content and low in fat compared with other cereals. It normally sells at a price 2 to 3 times that of cultivated rice. Eastern wild rice is *Z. aquatica* which is not cultivated, while *Z. palustris* is cultivated. In 1963, a cultivar with reduced grain shattering was developed and allowed the use of harvesting equipment like cultivated rice. Cultivated wild rice is planted on dry ground and flooded to 6 inches with air seeding at 30 to 45 lbs per acre required the first year. The paddy will reseed itself and produce for 3 to 4 years in Minnesota. Fields are drained 3 weeks before harvest. Yields range from 50 - 1,750 lbs per acre. Approximately, 2.5 lbs of grain are processed into 1 lb of dry processed grain. Crop rotated with cultivated wild rice are buckwheat, rye, wheat, mustards, and forage grasses for seed production.

Usual Planting and Harvesting Dates:

The USDA provides state-level usual planting and harvesting dates for major field crops, along with dot maps showing major areas of production. Usual planting dates are the times when crops are usually planted in the field. Harvest dates refer to the periods during which harvest of the crops occurs. Usual planting and harvesting dates by state are available for barley (fall and spring), corn, oats, rice, sorghum, Durum wheat, spring wheat and winter wheat. The most recent publication date is October 2010 and this publication can be found USDA National Agricultural Library, and NASS, USDA. 2010. Field Crops: Usual Planting and Harvesting Dates. USDA National Agricultural Statistics Service, Agriculural Handbook 628. ([HYPERLINK "https://downloads.usda.library.cornell.edu/usda-esmis/files/vm40xr56k/dv13zw65p/w9505297d/planting-10-29-2010.pdf"]).

PEST PROBLEMS FOR THE CEREAL GRAIN CROPS: (Developed from USDA Crop Profiles from AZ, CA, FL, IN, MD, NY, OR, TX, VA, WA, and USDA Agricultural Extension Bulletins, and Research Literature).

Problems with pests for the cereal grains are common because most cereal grains are from the same family (*Poaceae/Gramineae*).

Plant diseases are major constraints to the production of cereal grains. There are numerous fungal, bacterial and viral diseases that adversely impact cereal grain production. Fungal diseases include leaf rust (brown rust), stem rust (black rust), stripe rust (yellow rust), common and dwarf bunt (stinking smut), kernal bunt (partial bunt), loose smut, covered smut, powdery mildew, *Septoria tritici* blotch, *Septoria nodorum* blotch, *Septoria avenae* blotch, spot blotch (*Helminthosporium* leaf blotch), tan spot (Yellow leaf spot or blotch), *Alternaria* leaf blight, *Fusarium* leaf blotch (snow mold), scab (head blight), powdery mildew (*Erysiphe* spp.), ergot, corn smut, black point, diplodia rots,stem rust, downy mildew, take-all, eyespot (strawbreaker), leaf scald of barley, net blotch of barley, sharp eyespot and *Rhizoctonia* root rot, *Sclerotium* wilt (Southern blight) and black molds (sooty molds). Bacterial diseases include bacterial black chaff, bacteris wilt, bacterial stripe, basal glume rot, bacterial leaf blight, and bacterial spike blight (yellow ear rot). Viral diseases include barley yellow dwarf and mosaic variety

Insects can severely reduce yield, and spread plant diseases (aphids). Insect pests of cereal grains include aphids, chinkbug, stink bugs, armyworms, cutworms, leafhopper, stalk borers, cereal leaf beetle, sugarcane beetle, thrips, Hessian fly, wheat stem maggot, sawfly, white grubs, wireworms, swheat jointworm, lugs, snails, grasshoppers, crickets and mites. Nematode pests include seed gall nematode (wheat nematode or ear cockle), cereal cyst nematode and root know nematode.

In addition, there are numerous insect pests of stored grain including granary weevil, saw-toothed grain beetle, red flour beetle, larger cabinet beetle, lesser gain borer, rice weevil, indianmeal moth, cadelle, flat grain beetle and Angoumois grain moth (Purdue Extension, 2010).

Herbicides are needed for effective weed control of both annual and perennial broadleaf and grass weeds in cereal grains. Weeds compete with developing plants, reduce grain or forage yields, interfere with harvesting, reduce grain quality and contaminate harvested grain.

CROP ROTATIONS FOR THE CEREAL GRAINS. (Adopted from Schneider, 1990, 1998, Swiader, 1992, [HYPERLINK "http://www.dannylipford.com/vegetable-garden-crop-rotation-made-easy/"]).

Crop rotation is the practice of growing different crops, rather than the same vegetable or members of the same family of vegetables, in the same place each year. Crop rotation benefits cereal crops in two ways: first, it will prevent the build-up of soil-borne pests, weeds, and diseases; second, it allows for the replenishment and efficient use of soil nutrients. Cereals should not be grown the same area year after year or more than once every three or four years in the same field. Crop rotation will vary by region and availability of moisture. Small grains often rotated to safflower.

Sweet corn is rotated with potatoes. Corn is also rotated wih soybeans in the corn belt. Wheat often follow corn or a legume. Wheat is rotated with any non-cereal crop. Sorghum is rotated with ncotton or soybeans. In the wheat belt a common rotatrion is alfalfa-corn-wheat. Wheat is often rotated to corn followed by soybeans or canola. Barley rotations are similar to wheat. Oats often follow a` row crop. Grain sorghum fits well into several crop rotations and fits into a double crop production system. Some rotated crops are small grains, cotton, soybeans and cotton

Crop rotations for rice can vary by region. In California, approximately 30% of the rice is grown in rotatiojn with other crops suca as safflower, corn, wheat, grain sorghum, dry beans, sugarbeets, vegetable seed crops, and tomatoes. Approximately 70% odf the rice in California is in a rice-rice 0r rice- fallow rotation. In the Delta states (MS, LA, AR, MO) rice is rotated with cotton, soybeans, corn, oats, lespedeza, or a winter legume for a green manure crop, and can be grown in a 2 tea – 5 year before rotating. Rotations with corn, sorghum, soybeans, or cotton have significantly reduced red rice infestations in the Delta Region (Schneider, 1996).

Weed problems may also be reduced by rotations, since different herbicides can be used in rotations to control various weeds. Rotations to a cover crop like a cereal grain or alfalfa can help reduce the weed competitiveness with various cereal grain crops.

Crop rotation also helps prevent soil nutrients from being depleted. Members of the same vegetable family usually draw the same nutrients from the soil. Crop rotation will prevent the soil from wearing out: heavy nitrogen, phosphorus, and potassium feeding crops. Sugar beet crops exhaust the soil rapidly. Crop rotation is recommended and necessary. Normally, sugarbeets are grown in the same ground every third year, peas, beans or cereal grain being raised the other two years.

The Grass Family (*Poaceae/Gramineae*) inclides Grains–corn, oats, rye, wheat. Follow these crops with members of the tomato or *Solanaceae* family, and legume family.

COMPARISON OF RAW AGRICULTURAL COMMODITY (RAC), LIVESTOCK FEED ITEMS, PROCESSED FOOD ITEMS, POSTHARVEST HANDLING AND EDIBLE PORTIONS FOR THE CEREAL GRAINS:

The raw agricultural commodities (RAC) for the proposed amended Cereal Grain Crop Group, but they are the same ones in the original crop group and the feedstuffs are the same for the Cereal Grain Crop Group 15 (**Table 25**).

Table 25. Raw Agricultural and Process Commodities and Feedstuffs from Cereal Grains (OPPTS 860.1000).

Table 1 — Raw Agricultural and Processed Commodities and Feedstuffs Derived from Crops

Crop	Raw Agricultural Commodity	Processed Commodity	Feedstuff		Percent of Livestock Diet (1, 2)			
			Feedstuff	% DM (3)	Beef Cattle	Dairy Cattle	Poultry	Swine
Barley (11)	grain (12) hay	pearled barley flour bran	grain (12)	88	50	40	75	80
			hay	88	25	60	NU	NU
			straw	89	10	10	NU	NU
Buckwheat	grain (16)	flour	....	....	....	....	....	....
Corn, field	grain starch (25) forage (22) stover (23) grits flour aspirated grain fractions (24)	wet milling: oil, refined dry milling: meal oil, refined	grain	88	80	40	80	80
			forage (22)	40	40	50	NU	NU
			stover (23)	83	25	15	NU	NU
			aspirated grain fractions (24)	85	20	20	NU	20
			milled byproducts (26)	85	50	25	60	75
Corn, pop	grain	....	grain	88	80	40	80	80
	stover (23)	....	stover (23)	85	25	15	NU	NU
Corn, sweet (27)	sweet corn, K + CWHR (28)	....	forage (29)	48	40	50	NU	NU
	forage (29)	....	stover (23)	83	25	15	NU	NU
	stover (23)	....	cannery waste (30)	30	35	20	NU	NU
Millet (41)	grain (42) forage hay	flour (44)	grain (42)	88	50	40	70	75
			forage	30	25	60	NU	NU
			hay	85	25	60	NU	NU
			straw (43)	90	10	10	NU	NU
Oats (48)	grain (12) forage hay	flour groats/rolled oats	grain (12)	89	50	40	80	80
			forage	30	25	60	NU	NU
			hay	90	25	60	NU	NU
			straw	90	10	10	NU	NU

Table 25. Raw Agricultural and Processed Commodities and Feedstuffs from Cereal Grains from OPPTS 860.1000 (continued)

Table 1. — Raw Agricultural and Processed Commodities and Feedstuffs Derived From Crops - Continued

Crop	Raw Agricultural Commodity	Processed Commodity	Feedstuff		Percent of Livestock Diet (1, 2)			
			Feedstuff	% DM (3)	Beef Cattle	Dairy Cattle	Poultry	Swine
Rice (65)	grain (12)	polished rice	grain (12)	88	40	40	60	65
	straw	hulls	straw	90	10	10	NU	NU
		bran	hulls	90	10	10	15	NU
			bran	90	15	15	25	15
Rye (66)	grain (67)	flour	grain (67)	88	40	40	50	80
	forage	bran	forage	30	25	60	NU	NU
	straw		straw	88	10	10	NU	NU
Sorghum, grain	grain	flour (68)	grain	86	40	40	80	90
	forage (22)		forage (22)	35	40	50	NU	NU
	stover (23)		stover (23)	88	25	15	NU	NU
	aspirated grain fractions (24)		aspirated grain fractions (24)	85	20	20	NU	20
Sorghum forages, Sudan grass	(See Grass)	....	....	....	....	....	....	....
Wheat (79) (80)	grain (67)	bran flour	grain (67)	89	50	40	80	80
	forage	middlings	forage	25	25	60	NU	NU
	hay	shorts	hay	88	25	60	NU	NU
	straw	germ	straw	88	10	10	NU	NU
	aspirated grain fractions (24)		aspirated grain fractions (24)	85	20	20	NU	NU
			milled byproducts (81)	88	40	50	50	50

(ii) Table notes. See OPPT 860.1000 for footnotes.

[HYPERLINK \l "_Table_18._(OPPTS"] shows the suggested distribution of field trials by region for only cereal grains for crops requiring >3 trials (EPA Residue Chemistry Test Guidelines. OPPTS 860.500 Crop Field Trials). [HYPERLINK \l "_Table_19._(OPPTS"] has been modified to show a comparison of the regional distribution of cereal grains from Table 6 in

860.1500 (1991 and 1987 data) versus data (2002 Census of Agriculture data) from the Methodology Report. Updating the Number and Location of Crop Field Trials for the United States of America.

Except for some shifting of percentages among regions ([HYPERLINK \l "_Table_19._(OPPTS"]), major changes in distribution are not evident for barley, field corn, sweet corn, oats, rice, wild rice and wheat. Buckwheat production has increased in Region 5 (15% to 23%), but decreased in Region 7 (66% to 36%). Popcorn production has decreased in Region 5 (91% to 70%), with an increase in Region 7 (0% to 11%). Proso millet production decreased in Region 5 (29% to 5%) and increased in Region 7 (35% to 47%) and Region 8 (35% to 42%). Rye production increased in Region 1 (4% to 11%), Region 2 (13% to 23% and Region 6 (0% to 18%), but decreased in Region 7 (42% to 1%). Grain sorghum production decreased in Region 7 (12% to 1%), but increased in Region 8 (29% to 35%). Most of these changes in cereal grain production occurred in Region 5 and Region 7. It is not likely that changes in trial requirements are needed based on these changes, except for possible changes in trial numbers for wheat and barley if accepted as representative crops. See also Table 28 for suggestion distribution of the field trials if barley is added as a representative commodity.

Table 26. OPPTS 860.1500, Table 5. — Suggested Distribution of Field Trials by Region for Crops Requiring >3 Trials

Crop	Total No. of Trials[1]	Number of Trials in Region												
		1	2	3	4	5	6	7	8	9	10	11	12	13
Barley	12	1[2]	1[2]			3		4		1	1	2		
	9	1[2]	1[2]			2		3		1	1	1		
Buckwheat	5	1				1		3						
Corn, Field	20	1	1			17	1							
	15	1	1			12	1							
Corn, Sweet	12	2	1	1		5					1	1	1	
	9	1	1	1		3					1	1	1	
Millet, Proso	5					1		2	2					
Oat	16	1	1			9	1	3	1					
	12	1	1			6	1	2	1					
Rice	16				11	1	2				2			
	12				7	1	2				2			
Rice, Wild	5					4					1			
Rye	5		1			2		2						
Sorghum, Grain	12		1		1	4	2	1	3					
	9				1	3	2	1	2					
Wheat	20		1		1	5	1	5	6			1		

	15		1		1	3	1	4	4			1		

[1] Where two entries are provided for a crop (with the exception of mustard greens and summer squash as explained below), the second is for situations where a 25 percent reduction in the number of trials is possible due to the crop being a representative commodity used to obtain a crop group tolerance or due to the pesticidal use resulting in no quantifiable residues.
[2] Either region is acceptable.
[3] A minimum of five trials is required on any one blackberry or any one raspberry if a tolerance is sought on "caneberries" (see Table 3 or Table 4 of this appendix). A minimum of three trials is needed if a tolerance is sought on only blackberries or only on raspberries.
[4] A minimum of eight trials is required on mustard greens if a tolerance is sought on the crop subgroup leafy Brassica greens (see Table 3 of this appendix). A minimum of five trials is required if a tolerance is sought on only mustard greens.
[5] A minimum of five trials is required for a tolerance on "summer squash". If a tolerance is sought on "squash", at least 8 trials are required on summer squash as a representative commodity (see Table 4 of this appendix). Alternatively, five trials each could be conducted on summer squash and winter squash to obtain a tolerance on "squash".
[6] Although regional production figures are not provided in Table 6 of this appendix for rapeseed, cowpea forage/hay, and cowpea succulent shelled bean, sufficient information is available for determining suggested regions for these crops

Table 27. OPPTS 860.1500, Table 6. — Regional Distribution of Crop Production Changese Using 2012 USDA AGCensus.

Crop	Total percent Production Accounted	Percentage of Crop Production (Acreage Basis) in Region												
		1	2	3	4	5	6	7	8	9	10	11	12	13
Barley (860.1500) [1]	99	2	2			29		36	2	6	3	19		
Barley, grain (2002) [2]	99	3	3	0	0	23	0	24	1	17	2	26	0	0
Buckwheat [1]	96	15				15		66						
Buckwheat (2002) [2]	77	11	0	0	0	23	0	36	0	0	0	8	0	0
Corn, Field [1]	97	3	6			86	2							
Corn, Field, grain (2002) [2]	100	3	3	0	2	83	2	3	4	0	0	0	0	0
Corn, Field, forage (2002) [2]	99	22	5	0	0	46	1	6	7	1	6	3	1	0
Corn, Pop [1]	95					91			4					
Corn, Pop (2002) [2]	83	0	0	0	0	70	0	11	0	0	0	0	0	0
Corn, Sweet [1]	96	13	4	8		50					3	11	7	
Corn, Sweet (2002) [2]	92	12	9	4	0	40	0	0	1	1	3	16	5	1
Millet, Proso [1]	99					29		35	35					
Millet, Proso, grain (2002) [2]	94	0	0	0	0	5	0	47	42	0	0	0	0	0
Oat [1]	97	8	2			61	3	20	3					
Oat, grain (2002) [2]	98	13	4	0	0	53	5	14	2	2	2	2	1	0
Rice [1]	100				70	3	13				15			
Rice, grain (2002) [2]	99	0	0	0	71	5	6	0	0	0	17	0	0	0
Rice, Wild [1]	100					79					21			
Rice, wild (2002) [2]	86	0	0	0	0	51	0	0	0	0	18	12	5	0
Rye [1]	97	4	13	2		32		42	4					
Rye, grain (2002) [2]	84	11	23	1	0	23	18	1	6	0	0	0	0	0
Sorghum, Grain [1]	100		2		6	34	17	12	29					

Crop	Total percent Production Accounted	Percentage of Crop Production (Acreage Basis) in Region												
		1	2	3	4	5	6	7	8	9	10	11	12	13
Sorghum, grain (2002) [2]	99	0	1	0	6	34	21	1	35	0	0	0	0	0
Sorghum, forage (2002) [2]	86	3	4	0	0	25	13	5	33	0	3	0	0	0
Wheat [1]	94		4		4	23	6	26	26			5		
Wheat, grain (2002) [2]	100	0	3	0	3	33	8	22	17	2	1	10	0	0
Wheat, hay (2002) [2]	97	3	7	0	2	18	19	22	9	4	7	4	1	0

[1] Data from 860.1500 (Department of Agriculture, 1991 and Department of Commerce, Census of Agriculture, 1987).
[2] Methodology Report. Updating the Number and Location of Crop Field Trials for the United States of America (data from 2002 Census of Agriculture).

Table 28. OPPTS 860.1500, Table 5. — Suggested Distribution of Field Trials by Region for Crops Requiring >3 Trials with Proposed Representative Commodities.

Crop	Total No.	Number of Trials in Region												
		1	2	3	4	5	6	7	8	9	10	11	12	13
Barley	12	12	12			3		4		1	1	2		
	9	12	12			2		3		1	1	1		
Buckwheat	5	1				1		3						
Corn, Field	20	1	1			17	1							
	15	1	1			12	1							
Corn, Sweet	12	2	1	1		5					1	1	1	
	9	1	1	1		3					1	1	1	
Millet, Proso	5					1		2	2					
Oat	16	1	1			9	1	3	1					
	12	1	1			6	1	2	1					
Rice	16				11	1	2				2			
	12				7	1	2				2			
Rice, Wild	5					4					1			
Rye	5		1			2		2						
Sorghum, Grain	12		1		1	4	2	1	3					
	9				1	3	2	1	2					
Wheat	20		1		1	5	1	5	6			1		
	15		1		1	3	1	4	4			1		

1 Where two entries are provided for a crop, the second is for situations where a 25% reduction in the number of trials is possible due to the crop being a representative commodity used to obtain a crop group tolerance or due to the pesticidal use resulting in no quantifiable residues.
2 Either region is acceptable.

Regional distribution for Cereal Grain Crops that are not representative commodities are listed in Table 26

Table 29. EPA Crop Production Regions for the Cereal Grain Crops.

Commodity**	1	2	3	4	5	6	7	8	9	10	11	12	13
Amaranth, grain					X		X						
Canarygrass, annual					X		X						
Chia		X								X			
Corn, pop					X			X					
Millet, foxtail					X	X	X	X					
Millet, little					X	X	X						
Millet, pearl		X	X	X		X							X
Quinoa									X	X	X		
Psyllium										X	X		
Rye	X	X	X		X		X	X					
Teff							X		X		X		
Triticale		X					X	X	X		X		
Wheatgrass, intermediate							X	X	X		X		

COMPARISON OF POTENTIAL RESIDUE LEVELS IN CEREAL GRAINS:

Magness, Markle, and Compton in 1971 classified food and feed crops based on predicting the potential for pesticide residues based on exposure of the edible parts to applied pesticides, which led to the development of the crop groups. Only one class was designated for grain crops since they are all similar in their degree of exposure to applied pesticides. In most grains, except in oats and barley, the kernels or seeds are enclosed in papery covering until harvested. These are usually removed during threshing. These seeds may be closely packed on a base as in corn, in compact spike or head as in wheat and barley, or in compact or loose panicles as in oats, rice and sorghum

Therefore, we expect that all proposed members of the amended Cereal grain crop group 15) and Forage, Fodder and Straw of Cereal Grain crop group 16 will have similar residue levels based on similarities of the raw agricultural commodities (RAC's), cultural practices, and pest problems. The current Cereal Grain and Forage, Fodder and Straw Does ChemSAC concur with the IR-4 proposal that one new commodity definitions [40 CFR § 180.1(g)]? "Does ChemSAC concur with the initial IR-4 proposal that one new commodity definitions [40 CFR § 180.1(g)] will be needed for this amended crop group for sugarcane which will cover sweet sorghum to harmonize with Codex (See Table below)? Also, IR-4 feels the current commodity definitions are adequate, and do not need changing. Does ChemSAC concur with the IR-4 proposal that one new commodity definitions [40 CFR § 180.1(g)]? "Does ChemSAC concur with the initial IR-4 proposal that one new commodity definitions [40 CFR § 180.1(g)] will be needed for this amended crop group for sugarcane which will cover sweet sorghum to harmonize with Codex (See Table below)? Also, IR-4 feels the current commodity definitions are adequate, and do not need changing. Does ChemSAC concur with the IR-4 proposal that one new commodity definitions [40 CFR § 180.1(g)]? "Does ChemSAC concur with the initial IR-4 proposal that one new commodity definitions [40 CFR § 180.1(g)] will be needed for this amended crop group for sugarcane which will cover sweet sorghum to harmonize with Codex (See Table below)? Also, IR-4 feels the current commodity definitions are adequate, and do not need changing.

There are over 100 tolerances for the Cereal grain crop group 15 and 16 (See APPENDIX in separate document.

It should be noted that BCI uses terms like fodder for all members of the crop group that is not valid because the major cereal grain such as corn and grain sorghum have only stover, no fodder term has been used by Agronomists since 1954.

PROCESSING OF CEREAL GRAINS (See also B. Schneider, Uses of Brans of Wheat, Oats, Barley, and Rye as Foods).:

Cereals are processed in many ways, but the methods are broadly grouped into wet milling, dry milling, oil processing, fermentation, and feed processing. Characteristic features of milling processes include separation of the endosperm from the embryo and seed coat, and reduction of the endosperm into flour or grits. Milling schemes are classified as wet or dry, but this is a relative classification because water is used in almost all separations. Few generalizations can be made about cereal milling. For example, most rice is milled in two stages to remove the husk and then the bran, however, some is milled into flour. There are dry milling processes that change the shape and size of cereal. Fractions produced by this step are frequently separated in another step. An additional milling process can be completed by changing the temperature or water content. Unlike dry milling, which primarily just fractionates, wet milling is a maceration process in which physical and chemical changes occur in the basic constituents: starch, protein, and cell wall material. The objective is complete dissociation of the endosperm cell contents with the release of the starch granules from the protein network. Processing has taken a huge step from [HYPERLINK "https://www.encyclopedia.com/social-sciences-and-law/anthropology-and-archaeology/human-evolution/stone-age"] grinding stones for dry milling to soaking processes to remove starch to modern milling and extrusion processes. Milling processes today are almost entirely based on meeting product specifications by the most efficient means possible with almost all steps controlled mechanically and electronically.

The other primary processing method is production of alcohol from cereal grains through a fermentation process. This two-step process includes the conversion of starch to soluble sugars by amylolytic enzymes, followed by the conversion of the sugars into alcohol. In the first step the enzymes may be derived from the grain itself (malting), from other organisms present or added as extracts. The malting process has also been used to produce some breakfast foods. It is comprised of a controlled germination during which enzymes capable of catalyzing hydrolysis of starch are produced. The fermentation process results in the development of alcoholic drinks, including beer and sake. Further processing by evaporating and condensing increases the alcohol content and produces whiskey, scotch, bourbon, and neutral spirits, including those used for production of fuel. Today production of gasohol ranks as one of the largest uses of corn following its use as animal feed. The byproducts of fermentation are primarily used as livestock feed.

These cereal grain tissues are further processed during milling by grinding, polishing, scraping, and/or abrasive means. For example, the wheat kernel is milled into the following major fractions: (1) flour consisting of endosperm and a portion of the aleurone layer; (2) middlings or shorts which consists of the aleurone layer and a portion of the bran; (3) germ which consists of the embryo and some bran; and (4) the bran layer or fraction which contains >90% of the bran. The bran layer is comprised of pericarp, testa, nucellar layer, and the aleurone layer (one to three cells thick dependent on cereal crop and is often colored brown or purple), also acts like a protective shell around the germ and endosperm tissues, and provides nutrients to the embryo.

Table 30. Information for Milling Cereal Grain Commodities:

Crop	**Milling of Cereal Grains**
Amaranth, Grain	The seed consists of an outer layer or hull, an inner layer, the seed coat proper, and within this a starchy endosperm and the germ. In milling the hull, which comprises 18 to 20% of the whole grain weight, is first removed. A second milling removes most of the seed coat or "middlings" which comprise 4 to 18% of the whole grain weight, depending on how completely the seed coat tissues are removed. In most buckwheat flour, some of the seed coat particles remain, resulting in a light brown color. More complete milling results in white flour.
Barley	Barley bran is a significant food in the U.S. and is used in cooking, cake, cookie and bread. Bran is obtained from milling of brewers spent grain and not the traditional dry milling of barely grain. Barley flakes (rolled barley) are used in hot cereal or as a thickening agent.
Buckwheat	In milling the hull, which comprises 18 - 20% of the whole grain weight, is first removed. A second milling removes most of the seed coat or "middlings" which comprise 4 to 18% of the whole grain weight, depending on how completely the seed coat tissues are removed. In most buckwheat flour, some of the seed coat particles remain, resulting in a light brown color. More complete milling results in white flour.
Corn, field	Corn grain is either dry or wet milled. Dry milling is primarily concerned with separation of the parts of the grain. Wet milling provides the same separation but further separates some of those parts into their chemical constituents, primarily starch, protein, oil, and fiber. Dry

Crop	Milling of Cereal Grains
	milling provides bran, germ, and endosperm. Corn grains, silage, stover, forage, aspirated grain fractions, cannery waste and milled byproducts are used for livestock feed.
Rice	The primary use of rice is for human food. Primary culinary variants include stickiness and aroma. For food use the hull, present on the threshed or "rough" rice, is first removed. In Oriental countries, for home use this may be done by use of a hollow block and wooden pounder, which leaves the bran layer and the germ on the rice. In the United States, other Occidental countries, and to a considerable extent in the Orient, rice is machine milled. This removes the hull, bran, germ, and some of the endosperm. The first step after cleaning the rice to remove any chaff and foreign matter, is to pass the kernels through a sheller which may consist of paired rubber rollers revolving at different speeds. Hulling stones may also be used. One horizontal stone is stationary and a second one revolves. When properly spaced they loosen the hulls with minimum kernel breakage. The product from this step is brown rice, the bran layer and germ being still present on the grain. Brown rice is generally further milled in this and other Occidental countries to remove the bran and germ. This is accomplished by rubbing or scouring. A final step is termed brushing. It consists of passing the rice through a rapidly revolving vertical cylinder covered with overlapping pieces of cowhide or pigskin. This results in a polished surface on the grains. A step termed parboiling, preliminary to hulling, is often used in Oriental countries and to some extent in this country. The rough rice is first soaked, then steamed either under pressure or without pressure, and subsequently dried before removing the hulls. This results in a toughening of the endosperm and less breakage. Also, minerals and vitamins present in the bran and embryo move into the grain proper to some extent, so parboiled rice is higher in these important nutrients than rice hulled without such treatment. In this country, a process having a

Crop	Milling of Cereal Grains
	similar effect is sometimes used. The rough rice is first put under vacuum to remove air, then is soaked under pressure and finally steamed under pressure. This process shortens the time of treatment compared with parboiling and results in similar reduced breakage of the endosperm and enhanced nutritive value. Milled rice is used mainly for direct consumption, usually after cooking by boiling. It may be sold as precooked or partially precooked rice. Rice is also used extensively as breakfast foods, as puffed rice, flakes, or rice crispies. Broken rice may be used as food or in manufacture of alcoholic beverages. Rice flour, a product of final milling, is used in various mixes. The bran is used mainly as livestock feed. Rice hulls are used for fuel, insulation, mulch, and in certain manufacturing processes. About 80% of the rice in the U.S. is used for human food and 16% for brewers use. Rice oil can be extracted from brown rice and used for salad dressing, cooking oil and soaps. Glutinuous rice, also called nomi, waxy or sweet rice, is used for desserts.

Types of Flour from Cereals. ([HYPERLINK "http://www.namamillers.org/education/types-of-flour/"]).

The harder the wheat, the higher the protein content in the flour. Soft, low protein wheats are used for cakes, pastries, cookies, crackers and Oriental noodles, while hard, high protein wheats make excellent breads and quick breads. Durum is used in pasta and egg noodles.

White flour: The finely ground endosperm of the wheat kernel.

All-purpose flour: White flour milled from hard wheats or a blend of hard and soft wheats. It gives the best results for a variety of products, including some yeast breads, quick breads, cakes, cookies, pastries and noodles. All-purpose flour is usually enriched and may be bleached or unbleached. Bleaching will not affect nutrient value. Different brands will vary in performance. Protein content varies from 8 - 11%.

Bread flour: White flour that is a blend of hard, high protein wheats and has greater gluten strength and protein content than all-purpose flour. Unbleached and in some cases conditioned with ascorbic acid, bread flour is milled primarily for commercial bakers, but is available at most grocery stores. Protein varies from 12 – 14%.

Cake flour: Fine-textured, silky flour milled from soft wheats with low protein content. It is used to make cakes, cookies, crackers, quick breads and some types of pastry. Cake flour has a greater percentage of starch and less protein, which keeps cakes and pastries tender and delicate. Protein varies from 7 - 9%.

Self-rising flour: Also referred to as phosphate flour, a convenience product made by adding salt and leavening to all-purpose flour. It is commonly used in biscuits and quick breads; bur is not recommended for yeast breads. One cup of self-rising flour contains 1 ½ teaspoons baking powder and ½ teaspoon salt. Self-rising can be substituted for all-purpose flour by reducing salt and baking powder.

Pastry flour: Has properties intermediate between those of all-purpose and cake flours. It is usually milled from soft wheat for pastry-making, but can be used for cookies, cakes, crackers and similar products. It differs from hard wheat flour in that it has a finer texture and lighter consistency. Protein varies from 8 - 9%.

Semolina: The coarsely ground endosperm of durum, a hard spring wheat with a high gluten content and golden color. It is hard, granular and resembles sugar. Semolina is usually enriched and is used to make couscous and pasta products such as spaghetti, vermicelli, macaroni and lasagna noodles. Except for some specialty products, breads are seldom make with semolina.

Durum flour: Finely ground semolina. It is usually enriched and used to make noodles.

Whole wheat, stone ground and graham flour: Can be used interchangeably and nutrient values differ minimally. Either grinding the whole-wheat kernel or recombining the white flour, germ and bran that have been separated during milling produces them. Their only differences may be in coarseness and protein content. Insoluble fiber content is higher than in white flours.

Gluten flour: Usually milled from spring wheat and has a high protein (40 – 45%), low-starch content. It is used primarily for diabetic breads, or mixed with other non-wheat or low-protein wheat flours to produce a stronger dough structure. Gluten flour improves baking quality and produces high-protein gluten bread.

Wheat Milling Process:

The U.S. grain processing industry has evolved to efficiently co-mingle and move vast quantities of grain from rural America to population centers so consumers can have safe, healthful products with consistent quality.

Each year the U.S. wheat milling industry consumes more than 900 million bushels of an approximately two-billion-bushel crop. U.S. wheat mills of average size produce about one million pounds of flour daily, and the largest produce between 2.0 - 3.2 million pounds per day.

Wheat is not just wheat, there are six classes and several hundred varieties of wheat make possible the hundreds of wheat foods made worldwide. For example, hard wheat flours provide for a variety of bread products; durum semolina and flour are used in pasta. Soft wheat flours produce an array of crackers, cookies, cereals, cakes, pancakes, breading and pastries. Many mills specialize in the type of wheat they process and this specialization can be based, in part, on mill location.

Grain is delivered to mills by covered trucks and hopper railcars. The distance the grain has traveled varies greatly. In some cases, it has traveled hundreds of miles in a 110-car unit train. In other instances, it is being delivered from a local farm in the same county. Grain deliveries will frequently have gone through several aggregation steps prior to arriving at the mill (farmer, country elevator, terminal elevator etc.). The number of conveyances making deliveries of grain can vary depending on the time of year with more deliveries at harvest time.

Grain Standards

Before wheat is unloaded at a facility, samples are taken to ensure it passes inspection. Grain is tested for moisture content, test weight, unsound kernels, and foreign material. Grain is graded according to the US Grain Standards and is also subject to commercial specifications set by the miller. Typically, wheat used in milling is #2 grade or better. At unloading, product control chemists begin their tests to classify wheat and determine end-use qualities. The results from these tests determine how the wheat will be handled and stored.

The U.S. Grain Standards Act facilitates trading in grain. Administered by the USDA's Grain Inspection, Packers and Stockyards Administration (GIPSA) it provides criteria for determining the kind, class, and condition of grains and oilseeds. Standards define quality and condition factors and set grade limits based on those factor determinations. Mills, however, must use commercial specifications that are even more rigorous than the U.S. Grain Standards when testing for natural toxins, evidence of pest exposure, stress cracks, etc. Sampling, grading and testing of grade and quality factors continues throughout the storage, handling and milling processes.

Grain storage:

Once the grain has passed inspection it is unloaded directly from the delivery vehicle into pits and moved via conveyors and bucket elevators into large bins or silos. Storing grain is a science. The right moisture, heat and air must be maintained or the wheat may mildew, sprout, or ferment. During storage, the grain may go through a fumigation process to eliminate insect pests. Wheat is stored according to its protein level and other quality considerations. Storage times vary. Many mills will clean the wheat now to obtain better storage results. Millers frequently draw from different silos to blend different types of wheat with distinct performance properties to achieve the desired end-product.

Milling pre-requisite programs consist of inspection and testing of raw grain as it arrives at the mill, sanitation programs, pest control programs, current Good Manufacturing Practices (GMPs), traceability and recall programs, shipping and receiving procedures that cover truck and railcar inspections and sealing, chemical control programs, allergen control programs, customer complaint responses, and lab testing procedures as well as many others. These programs also cover preventative maintenance programs, machinery and equipment programs, supplier programs, grounds and facilities programs.

Several steps in the milling process enhance product integrity. When it is time to mill the grain, it moves from the bottom of the silo/bin through conveyors to the top floor of the mill where the cleaning process begins.

Storage and Transportation

Compared with many other crops, cereals and pseudo-cereals are extremely amenable to storage. The moisture content at harvest is typically below 15% and their composition and seed coats are such that deterioration is slow. Seasonal harvest with a continuous demand means that storage between harvests is required. Under typical conditions this need can be met easily; with care, storage for many years without serious loss of quality is possible. Storage during times of surplus is a part of human history, and with benefits of modern technology, cool dry conditions can be maintained and storage can be successful for extended periods of time. There are, however, problems with storage, including excessive moisture content at the time of storage, excessive temperature, microbial, insect, and spider infestation, rodent and bird predation, mechanical damage, and biochemical deterioration. The latter is especially important for cereals and pseudocereals with higher than normal oil content because the oil becomes rancid over time.

Cleaning the wheat - The first milling steps involve equipment that separates grain from seeds and other grains, removes foreign materials that might have originated during the farmer's harvest such as metal, sticks, stones and straw; and scours the kernels of wheat. It can take as many as six steps. The machines that clean the grain are collectively called the cleaning house. Magnetic separator – The grain first passes by a magnet that removes ferrous metal particles. It will pass through other metal detectors after milling to ensure that no metal pieces are in the finished product. Magnets are also positioned throughout the milling process and at the last step prior to load-out.

Separator – Vibrating or rotating drum separators remove bits of wood, straw and almost anything else too big or too small to be the desired grain.

Aspirator – Air currents act as a vacuum to remove dust and lighter impurities.

De-stoner – Using gravity, the machine separates the heavy material from the light to remove stones that may be the same size as the desired grain.

Disc separator – The grain passes through a separator that identifies the size of the kernels even more closely. It rejects anything longer, shorter, more round, more angular or in any way a different shape. Scourer – The scourer removes outer husks, dirt in the kernel crease and any smaller impurities with an intense scouring action. Currents of air pull all the loosened material away.

Impact Entoleter –Centrifugal force breaks apart any unsound kernels or insect eggs and aspiration rejects them from the mill flow. From the entoleter, the sound wheat flows to grinding bins, large hoppers that control the feeding of the wheat to the actual milling process. Color Separator – Newer mills may also utilize electronic color separators to simplify the cleaning process.

Tempering wheat:

Now the wheat is ready to be conditioned for milling. This is called tempering. Moisture is added in precise amounts to toughen the bran and mellow the inner endosperm. This makes the parts of the kernel separate more easily and cleanly. The length of soaking time can range from 6 - 24 hours. The time and temperature depend on the type of wheat and its moisture level. Temper water may be treated with ozone or chlorine to maintain sanitation in this wet environment during the tempering process.

Grinding wheat

The wheat kernels are now ready to be milled into flour. The modern milling process is a gradual reduction of the wheat kernels through a process of grinding and sifting. The millers' skill is analyzing the wheat and then blending it to meet the requirements of the end use. This science of analysis, blending, grinding, sifting and blending again results in consistent end products.

Wheat kernels are measured or fed from the bins to the "roller mills", corrugated cylinders made from chilled steel. The rolls are paired and rotate inward against each other, moving at different speeds. Passing through the corrugated "first break" rolls begins the separation of bran, endosperm (starch) and germ.

There are about five roller mills or breaks in the system. The goal is to remove the endosperm from the bran and the germ. Each break roll must be set to get as much pure endosperm as possible. The "break" rolls, each have successively finer corrugations. After each trip through the break rolls, the grist is sent back upstairs to drop through sifters. The system reworks the coarse stocks from the sifters and reduces the wheat particles to granular "middlings" that are as free from bran as possible. In some mills, double high roller mills eliminate elevating and sifting the product between two successive passages in the milling process, thus increasing efficiency.

The broken particles of wheat are elevated through pneumatic tubes and then dropped into huge, vibrating, box-like sifters where they are shaken through a series of bolting cloths or screens to separate the larger from the smaller particles. Inside the sifter, there may be as many as 27 frames, each covered with either a nylon or stainless-steel screen, with square openings that get smaller and smaller the farther down they go. Up to six different sizes of particles may come from a single sifter. Larger particles are shaken off from the top, or "scalped," leaving the finer flour to sift to the bottom. The "scalped" fractions of endosperm called middlings are reduced in a smooth roller system to the particle size of flour. In hard wheat mills, the product is then subjected to a purifying process. A controlled flow of air lifts off bran particles while at the same time a bolting cloth separates and grades coarser fractions by size and quality. This process is repeated, sifters to purifiers to reducing rolls, moving up and down and across the mill in a series until the maximum amount of flour is separated, about 75% of the wheat kernel.

Bleaching the flour:

Toward the end of the line in the millstream, if the flour is to be "bleached," the finished flour flows through a device that releases a bleaching-maturing agent in measured amounts. This duplicates the natural oxidation that occurs when flour can naturally age as in the old days when flour was stored for a few months. This whitened the flour and improved its baking characteristics. The modern bleaching process simply duplicates this natural oxidation process, but does so more quickly. In the bleaching process, flour is exposed to chlorine gas or benzoyl peroxide to whiten and brighten flour color. The bleaching agents react and do not leave harmful residues or destroy nutrients. In soft wheat products chlorine gas is also used to control cookie diameter and cake height.

Enrichment, malt and leavening: The flour stream passes through a device that measures out and releases specified quantities of enrichment. Malt may be added to bread flours at this point to add loaf height as well for flavor.

Grains have been enriched since 1941 with iron and the B vitamins riboflavin, niacin and thiamine. Thus, the crippling diseases pellagra and beriberi have been eradicated from the U.S. population. In 1998, folic acid was added to the enrichment formula. Data from U.S. birth certificates indicate neural tube defects have decreased by 19% and spina bifida by 23% following folic acid fortification in the U.S. grain food supply. Enriched grain products have more than twice the amount of folic acid as whole wheat. A slice of enriched white bread has 37 mcg versus whole wheat at 17.5 mcg.

Finished product testing: After milling, lab tests are run to ensure that the flour meets specifications. Millers also conduct routine monitoring of indicator natural organisms. Although dry flour does not provide an environment that is conducive to microbial growth, it is important to understand that flour is a minimally processed agricultural ingredient and is not a ready-to-eat product. Flour is not intended to be consumed raw. The heat processes of baking, frying, boiling and cooking are adequate to destroy any pathogens that may be present in flour and reduce the potential risk of food borne illness.

The North American Millers' Association is the trade association representing the wheat, corn, oat and rye milling industry. NAMA's 46 member companies operate 170 mills in 38 states and Canada. Their aggregate production of more than 175 million pounds per day is approximately 95% of the total industry capacity.

CORN MILLING:

Corn, which is native to the western hemisphere, is considered the most domesticated of all field crops. Today the US plants about 91.9 million acres of corn annually making it the largest producer of corn in the world.

The corn dry milling industry produces a wide variety of yellow and white corn products with the main product categories being degermed corn grits (the germ or embryo of the kernel is removed), corn meal, corn flour and corn bran. These, in turn, are used in several common foods, from breakfast cereals, to snack foods, baked good, beer, and even pet foods. Dry milled products are also used in such non-food items as building materials, ceramics, pharmaceuticals, paper goods, and textiles.

By-products derived from the corn milling process are corn oil, used in salad dressings, margarines and syrups, and hominy, primarily used as a source of starch and fiber in animal feed.

Millers in North America use milling quality "dent" or field corn, typically purchased directly from growers and leading dealers based on numerical grade, with a premium paid for the highest quality corn.

Corn Milling Process

Dry corn millers process corn in one of three ways: (1) a tempering degerming process; (2) stone-ground or nondegerming process; or (3) alkaline-cooked process. However, each miller has his own unique variations on the overall processing system.

The most common process is the "tempering-degerming." The first step in this process is to dry clean the corn, separating fines and broken from the whole corn. Occasionally wet cleaning follows to remove surface dirt, dust and other matter. The clean corn is tempered to 20% moisture. While moist, most the outer bran or pericarp, germ, and tip cap are removed, leaving the endosperm. The bulk of the corn endosperm, known as the "tail hominy fraction," proceeds through the degerminator, is dried, cooled, and sifted. A portion of this "fraction" is isolated as large flaking grits. Further separation is accomplished using roller mills, sifters, grinding tables, and aspirators so that an infinite variety of smaller grits, meals and flours can be produced.

The bran and germ "fractions" are passed through another part of the degerminator as the "through stock" stream. This stream is dried, cooked, and aspirated to remove the bran. Further processing separates the germ from any remaining endosperm. The "through stock" produces crude corn oil; hominy feed; bran products; standard meal; and prime grits, meals, and flours.

Whole ground or stone-ground mills most often use white corn to make food products such as hominy grits and corn meal. These products are essentially whole ground corn with very little of the hull and germ removed.

In the alkaline-cooked process, the corn is cooked in a boiling lime solution for 5 to 50 minutes depending on its intended use then steeped for 2 - 12 hours. The cooked and steeped corn is washed to remove excess alkali and the loose pericarp tissue. The resulting corn product is ground to form the popular masa flour. About 65% of the corn processed emerges as prime products and 35% as by-products.

Corn Product Uses

The coarsest product coming from the degerming process is grits, ranging in size from coarse to fine. The coarsest flaking grits, also known as hominy grits, are used for the manufacture of corn flakes. Other sizes of grits are sold separately or as a blend to the makers of breakfast cereals and snack foods and to brewers as brewer's grits.

A more finely ground product than girts, corn meal is used to produce corn bread, muffins, fritters, hush puppies and spoon bread. It is also used as an ingredient in products such as corn meal mixes, cereals, bakery mixes, pancake mixes, and snacks.

A finer granulation of corn meal is sold as corn cones which are used in many bakery mixes; breakfast cereals; and as dusting meal for pizzas, English muffins, and other similar products.

Three corn meal products are also purchased by the U.S. government for distribution under its food donation program: regular corn meal, soy fortified corn meal and corn soy blend (CSB). The products are intended to provide nutrition in the form of both calories and high-quality protein and contain varying amounts of corn meal as the basic ingredient.

The finest granulation of the dry corn milling process is corn flour. Corn flours are used in many dry mixes such as pancakes, muffins, doughnuts, breadings, and batters. Other uses include coatings, baby foods, meat products (as a filler and binder), cereals, and as a fermentation substrate.

The increased popularity of Mexican foods throughout the United States has created greater demand for tortillas and corn-based snack foods. A variety of masa flours are formulated by the alkaline-cooked process, each intended for a specific use. Masa dough can also be made from a mixture of corn flour and water. The masa is then used to prepare flat tortillas or used in the production of corn chips, tortilla chips, taco shells, tostados, and other snack items. Two food products derived from the "through stock" portion of the milling stream are corn germ flour and corn bran.

The extracted germ cake can be ground and dried to yield a high-quality food grade corn germ flour which is high in protein and is an excellent source of minerals. Corn germ flour is available on a limited basis for consumer food products.

Corn bran, an excellent source of dietary fiber, is becoming more important as an ingredient in the manufacture of corn bran cereal.

Crude corn oil is expelled or hexane-extracted from the germ. Dry millers get about .7 pounds of crude oil from one bushel (56 pounds) of corn via the expelled process and about 1.25 pounds of crude oil per bushel when hexane-extracted. The crude oil is then sold for further refining into edible oil.

The oil-extracted germ cake, bran, standard meal, and broken corn are generally combined, dried, and ground into hominy feed. As the major by-product of the dry corn milling process, hominy feed is used as an inexpensive, high-fiber, high-calorie ingredient in animal feed.

The less considered industrial uses of dry corn milled products have, in fact, been a growing part of the dry milling industry. Corn flours and chemically modified corn flours provide an inexpensive starch source used in making a variety of industrial products including insulation or fiber board, plywood and related laminating adhesives, compression-molded particle board, and wafer board. They are used for dry wall or gypsum board binders, foundry binders, and as the adhesive or binder in the production of charcoal briquettes.

OAT MILLING:

Oats are cereal grains whose origin can be traced back to about 2000 B.C. in the Middle East, particularly the areas surrounding the Mediterranean Sea. Some of the first evidence of oats were found in Egypt and parts of Switzerland.

There are several species of oats, but only two are of significant commercial importance. The avena sativa species accounts for 75% of world production, while the *Avena byzantina* species accounts for most of the remaining production. The *Avena nuda* species may gain importance in the future because of its hulless characteristics.

When mature, the oat plant is about 36 inches tall, and has several stalks per plant. The oat seeds are covered with a thick hull (except *Avena nuda*, which is enclosed in a papery sheath). There are normally up to four seeds per sheath, and the seeds hang on very fine, wiry stems. There are many of the seed sheaths per head, and the entire grain head can be up to 8 - 10 inches long. Canadian and domestic oats are planted in April/May and harvested in August/September.

Oat Milling Process:

Raw oats used by the oat milling industry undergo initial processes of cleaning and hulling. Cleaning removes the unwanted materials – such as corn, soybeans, foreign material, weed seeds, wheat, or barley. – from the milling quality oats. Various screening machinery, making size separation by length and width, remove these unwanted materials and size the oats. With the use of air, called aspiration, loose hulls and lighter feed grade oats are also removed.

The next step is the hulling process, where the outer shell (hull) is removed from the inner kernel, called the groat. The hull is removed by large machines that fling the oats against a rubber ring, knocking the hull off without damaging the groat.

These groats are then further processed to make an edible food product from a raw grain. The mixture of groats and loose hulls flow into another set of aspirators, where the much lighter hulls are blown off. The groats enter scouring machines where brushes clean the groats.

In the conditioning process, moisture content is increased before the groats pass through a kiln where they are heated using dry heat radiators to a temperature of approximately 215 F. During the heating process, steam inactivates enzymes present in raw grain, the groats are given a roasted nutty flavor, starch gelatinization occurs, and moisture level is reduced to a point acceptable for product storage. Adjustments are made to the conditioning system depending on the desired finished product characteristics.

Product then enters the sizing system where width graders are used to size the individual pieces. Large groats enter the groat stream, while small groats and broken pieces are sent to the cutting system. In the cutting system, steelcut is produced from the groats and broken pieces. A small sifter is used to segregate the large and small pieces of steelcut. Small pieces are often referred to as baby steelcut (baby flakes are produced from it), while the mixture is referred to as regular steelcut. The large pieces are called large steelcut.

The flaking system uses steelcut or groats as raw material and produces flakes. Before flaking, the products must be steamed to increase the moisture and elasticity. Large steelcut passes through the flaking mill to produce quick (minute oats, three minute) and thick quick, while baby steelcut produces baby flakes. Whole oat groats are rolled into various old-fashioned type flakes.

Following rolling, the flakes are dried to approximately 11% moisture on a bed dryer before being packaged.

The flour and bran system produces whole oat flour, or a combination of low bran oat flour and oat bran. Rollstands and hammermills are used to grind the product into flour or bran. Various granulations of both flour and bran can be produced.

Crushed oat products are produced using an attrition mill. Steelcut, groats, or flakes can be milled into crushed oat products. Granulation requirements determine which product to mill, and how to set the mill.

APPENDIX: Uses of Brans of Wheat, Oats, Barley, and Rye as Foods.

MEMORANDUM

SUBJECT: Uses of Brans of Wheat, Oats, Barley, and Rye as Foods.

FROM: Bernard Schneider, Ph.D., Plant Physiologist
Chemistry Branch Tolerance Support

TO: Edward Zager, Acting Chief
Chemistry Branch Tolerance Support

We have investigated the uses of the brans of wheat, oats, barley and rye as human foods and their availability to the consumer and conclude the following:

(1) Wheat bran and oat bran are significant human foods and should be classified as ready-to-eat commodities based on their being consumed similar to a condiment (i.e., being sprinkled on other ready-to-eat foods). Both wheat and oat bran are widely available to the consumer.

(2) Barley bran is also a significant human food in the United States. The barley bran is used commercially in cooking cakes, cookies, and bread and is obtained from the milling of brewer's spent grains (BSG), and not from the traditional way by dry milling barley grain. However, the potential use of barley bran as a healthy source of soluble fiber may encourage a return to the more conventional roller-milling of the grain. We believe barley bran is not a ready-to-eat food as it is thoroughly mixed with other grain products and assorted ingredients in preparation of baked goods. It is also not available to the consumer in its pure form. The minimum dilution factor for its use in foods is in its pure state at least 2X.

(3) Rye bran is predominately used as an animal feedstuff, and would be used in such low quantities as a food in the United States that we recommend tolerances not be required for pesticide residues in this commodity. In addition, rye bran for use in cooking is available only with portions of other rye grain commodities such as rye grits or dark rye flour. Rye bran is not generally available for consumer use as a distinct commodity and would have to be special ordered. Therefore, rye bran as consumed presently in the U.S. is not a ready-to-eat food. It would be diluted at least 2X when used in preparation of other brans.

Detailed Discussion

The information utilized in the investigation of wheat, oats, barley, and rye brans as human foods included a full literature search through DIALOG including Agricola, Food Science databases, and the USDA Current Research Information Service (CRIS) for projects on grains; USDA Agricultural Statistics; the Branch Commodity files; the information gathered in the update of the Residue Chemistry Table II (September 1995); contacts with grain milling companies and Grain Associations and mail-order grain catalog suppliers, as well as visits to health food and grocery stores to determine the consumer availability of the various brans.

OVERVIEW:

All grain crops are not related botanically, but have kernels or seeds of similar composition. Cereal grains which include barley, corn, millet, rice, rye, triticale, and wheat are all members of the grass (*Gramineae)* family. Other crops considered as grain crops are not related botanically and include: amaranth, buckwheat, quinoa, and teff. Cereal grains are significant food/feedstuffs to both humans and animals. The percent distribution for the food/feed and/or seed uses of the major cereal crops: wheat, oats, barley, and rye are contained in Table 1. Only 5% of the barley crop in the U.S. is used directly as a human food, since 52.8% is used for feed or seed and the other 42.2% is used for malting in the production of beer. Rye is also used in distiller's grains for making whisky.

Table 1. Average Food/Feed/Seed Uses (%) of the Cereal Grains for 1990-1991. (3, 91).

Cereal Grain	Food & Alcohol (%)	Feed & Residual (%)	Seed (%)
Wheat	66.7	25.1	8.2
Barley	47.2	48.9	3.9
Oats	28.1	65.9	6.0
Rye*	22.7	45.6	19.4

* 12.3% of rye is also used for nonfood/nonfeed industrial applications.

This report will discuss the food uses and in particular the processed milled fractions of the cereal grains with emphasis on the bran fractions of wheat, oats, barley, and rye and a determination will be made whether the bran fractions are significant human foods and which can be classified as ready-to-eat commodities.

CURRENT FOOD USES OF CEREAL GRAINS:

All the grain crop kernels or edible seeds are composed of three main parts: (1) bran, (2) endosperm, and (3) germ or embryo. Specific percentages for each of these parts are listed in Table 4 and will be discussed further in the "structures of the cereal grain or kernel" section and under the specific wheat, barley, oat, and rye bran sections. The cereal grains seed or caryopsis are also covered with an outer papery hull (lemma and palea) which must be removed during milling and are not a human food item, but classified as livestock feed items (Subdivision O: Table II, September 1995). The processed cereal grain commodities for which residue data are currently required are listed below in Table 2.

TABLE. 2. Cereal Grains and Their Processed Commodities (OPPTS, Table II, Subdivision O)*.

CEREAL GRAIN	PROCESSED COMMODITY
Wheat	bran, flour, middlings, shorts, germ
Oats	flour, groats/rolled oats
Barley	pearled barley, flour, bran
Rye	flour, bran

* From Raw Agricultural and Processed Commodities and Feedstuffs Derived from Field Crops, Subdivision O: TABLE II. September 1995. U.S. EPA.

The bran fraction is used as a source of fiber in human and livestock diets; the endosperm becomes the refined flour fractions and various milled byproducts used in human and livestock diets; and the germ or embryo becomes the source of protein-rich oils and vitamins for human diets and a germ meal for livestock and pet animals.

Breakfast cereals (9, 94) are defined by the cereal industry as either ready-to-eat (RTE) without further cooking cereals and ready-to-cook (RTC) or hot cereals (HC). While most RTE breakfast cereals are composed of several grains, HC such as oatmeal are usually made from only one grain, but multigrain mixtures are becoming more popular. Examples of RTE breakfast cereals are: flaked cereals - mostly whole grains such as wheat and rice; puffed cereals - puffed wheat, rice, corn, rye; shredded wheat - with some corn and rice added; and granola cereals - mostly rolled or quick oats. Hot cereals include: oatmeals made from dehulled rolled steel cut oats; farina from wheat endosperm; and corn grits. The newest trend in breakfast cereals is to increase the dietary fiber content by adding either oat, corn, and/or wheat bran, or by including the whole ground kernel in the cereal product.

In 1990 per capita consumption of RTE cereals was reported as 11.6 lb/yr, while HC consumption was reported at 3.6 lb/yr (94). Wheat accounts for 4.9 lb/person/yr respectively (See Table 3A), but consumptions of barley (Table 3A), oats, and rye (Table 3B) as a breakfast cereal are not reported separately. In 1985 (54) the hot cereal industry which includes oat, wheat, and multigrain cereals was reported as about 360 million lbs with oatmeal products accounting for 66% of the total HC market. Per capita consumption of oat food products was 13.1 lb/yr.

Table 3A. Total and Per Capita Civilian Consumption of Wheat and Barley as Food in the U.S. Averaged for 1992-93 (Ref. 91).

WHEAT			BARLEY	
Total Consumed[1] (Million Bu.)	Per capita consumption of wheat flour[2] (lbs.)	Per capita consumption of cereal (lbs.)	Total Consumed[3] (Million Bu.)	Per capita consumption of food products[4] (lbs.)
835	139	4.9	8.0	0.9

[1] Excludes quantities used in alcoholic beverages.
[2] Includes white, whole wheat, and semolina flour.
[3] Includes malt for food, breakfast food uses, pearl barley, and flour.
[4] Malt equivalent of barley food products.

Table 3B. Total and Per Capita Civilian Consumption of Oats and Rye as Food in the U.S. Averaged for 1992-93 (Ref. 91).

OATS		RYE	
Total Consumed[1] ((Million Bu.)	Per capita consumption of oat food products (lbs.)	Total Consumed[2] (Million Bu.)	Per capita consumption of rye flour (lbs.)
99	13.1	3.6	0.8

[1] Oats used in oatmeal, prepared breakfast foods, infant foods, and food products.
[2] Excludes quantities used in alcoholic beverages.

STRUCTURES (TISSUES) OF THE CEREAL GRAIN OR KERNEL:

All cereal grain crops share similar morphological structures. A cross section of the kernel starting from the outside inward through a cereal grain includes the pericarp, seedcoat or testa, nucellar layer, endosperm, and embryo or germ. The purpose of these structures are as follows: (1) pericarp - forms a protective layer over the entire kernel; (2) seedcoat or testa - forms a protective layer over the embryo and endosperm and is united with the pericarp; (3) endosperm fills the interior of the grain, except for the embryo and consists of the aleurone layer, starch and gluten cells; (4) the embryo or germ consists of scutellum, coleoptile, foliage leaves, and root. Table 4 compares the percent composition of the structures in cereal grains.

Table 4. Principal Parts and Proportions of the Mature Kernels of Different Cereal Grains (% bywt).

Cereal Grain	Pericarp (%)[1]	Aleurone (%)[1]	Endosperm (%)	Germ (%)
Wheat	9 - 10	3 - 4	83 - 86	2 - 3
Barley	3 - 8	7 - 8	82 - 88	2 - 3
Oats	25 - 41[2]	-	55 - 70	2 - 4
Rye	12 - 17[2]	-	80 - 85	2 - 4

[1] The bran layer includes the pericarp + the aleurone.
[2] For oats and rye the pericarp % includes estimates for the aleurone layer.

These cereal grain tissues are further processed during milling by grinding, polishing, scraping, and/or abrasive means. For example, the wheat kernel is milled into the following major fractions: (1) flour consisting of endosperm and a portion of the aleurone layer; (2) middlings or shorts which consists of the aleurone layer and a portion of the bran; (3) germ which consists of the embryo and some bran; and (4) the bran layer or fraction which contains >90% of the bran. The bran layer is comprised of pericarp, testa, nucellar layer, and the aleurone layer (one to three cells thick dependent on cereal crop and is often colored brown or purple), also acts like a protective shell around the germ and endosperm tissues, and provides nutrients to the embryo.

MILLING OF CEREAL GRAINS:

Cereal grains are milled to separate its various structures or tissues such as the bran and germ from the endosperm. The endosperm is further ground or reduced into smaller particles of flour. The cereal grains are also milled to make them more digestible and easier to cook. Different mechanical and physical properties of the endosperm, bran, and germ make their separation possible. For example, bran has larger, coarser particles, and is lighter than endosperm. At harvest, grains are cut and put through a thresher which removes the loose husks or hulls from certain grains such as wheat, rye, triticale and hulless barley. Other grains, such as barley and oats, retain their hull and must be ground or pearled to remove their husks during the milling process. The milling process scrapes the bran off the endosperm, and separates out the germ. The endosperm is then ground and sieved into finer particle sizes as flour. Flour containing the outer layers of the endosperm is darker, contains more bran and nutrition, and has less baking ability than flour produced from the center of the wheat kernel endosperm which is lighter, contains more starch, less bran and has a good baking quality. The original condition and quality of the cereal grain determine which milled byproducts are separated and sold by the mill with most milled byproducts such as middlings and shorts sold as livestock feeds. Purified whole grain flour will often have various amounts of germ and bran added back before it is sold for baking whole grain breads.

BRAN AND FIBER DEFINITIONS:

Bran is the outer coating (pericarp or seedcoat) of a cereal grain kernel after the hulls (lemma and palea) are removed during processing. It makes up a small percentage of the grain, but consists of several layers including the nutrient rich aleurone layer. In wheat and oats, the aleurone layer is a single row of cells (barley is 3 cells thick) rich in oil and protein. Milled dark flours contain a large percentage of the aleurone layer. The entire bran layer is a rich source of nutrients supplying 86% of the niacin, 43% of the riboflavin, and 66% of all the minerals in the grain, and almost all its dietary fiber. Fiber is found only in plants and includes the cellular structures that humans cannot digest completely, and is found primarily in the bran and germ fractions. A 0.5 cup serving of wheat bran contains 13.0 g fiber, compared to oat bran which contains 6.8 g fiber, and corn bran which contains 36.4 g fiber (3). In some grains such as wheat, rice, and corn the fiber is mostly insoluble (includes cellulose, hemicelluloses, and lignin), while in other grains such as oats and barley the fiber is mostly soluble (includes pectins, gums, mucilages).

Most bran over the years has been utilized as livestock feeds or as a food for peasants since Biblical times. However, recent clinical studies have determined that bran is important in the human diet, since it reduces certain types of cancers and cholesterol levels. The bran layer accounts for most of the total grain fiber with both soluble and insoluble forms. The insoluble/soluble forms of cereal brans are listed in Table 5. Rye bran content is similar to wheat. Insoluble types of fiber have been found to be beneficial in reducing colon cancer, while the soluble types are beneficial in reducing blood cholesterol levels. All whole grains contain the bran layer, but in the milling process to make refined grain products, the bran is milled off the grain as part of millfeeds which includes bran, shorts, red dog, and germ. The shorts and red dog commodities are mostly utilized as a livestock feed. The bran on some of the grain kernels such as wheat are easy to mill off as a separate fraction, while brans on barley and rye are held tenaciously and hard to mill off as a distinct fraction. Most bran available in the U.S. is wheat bran that has been milled and toasted and sometimes cooked for easier digestibility, and unprocessed oat bran is also available and very popular since it was found to reduce LDL cholesterol. Bran is a good substitute for bread crumbs as a coating before frying meats, or as a nutty topping for cakes and pastries, and is added to muffins. Bakers will specify that the grain millers provide them with a specific type and size or granulation (coarse or fine) of bran necessary for their baking needs. The next section will individually discuss the cereals brans, their uses, and importance.

Table 5. Percent Differences in Solubilities of Cereal Brans (79).

Bran Source	Bran Solubility	Soluble %	Insoluble %
Barley bran	3 - 9	91 - 97	
Oat bran	50	50	
Wheat bran	2 – 6	94 - 98	
Corn bran	0 - 2	98 – 100	

WHEAT BRAN

The wheat kernel before milling consists of bran (12-14%), endosperm (83-86%), and germ (2-3%) (see Table 4). Approximately, 100 lbs of wheat is processed into 72 to 75 lb. flour and 25 to 28 lb of wheat millfeeds as an important byproduct (32, 44). Of the 25 to 28 lb millfeeds produced, bran accounts for 50% and the middlings are >45%. A typical commercial wheat milled fraction mix is as follows:

Proportion of Wheat (% bywt.)

Patent flour	64.5 - 65.3
First clear flour -	5.2 - 5.5
Second clear flour	3.0 - 3.2
Red dog flour -	1.0 - 1.3
Shorts	8.4 - 15.0
Bran	12.0 - 16.4
Germ	0.2 - 2.0

The clear flours, red dog flour and shorts also contain some particles of wheat bran. The wheat millfeeds contain the bran and several other milled byproducts such as shorts and red dog flour that are not useful for a high-quality flour and are predominately used as animal feedstuffs (Table 6). The bran accounts for 50% of the wheat millfeeds or approximately 3,529,000 tons), and it is estimated that >90% of the bran is utilized in livestock feeds, and ≤10 % for human foods or about 352,850 tons/yr.

Table 6. Wheat millfeeds produced during 1991-1993 (3, 91).

YEAR	WHEAT MILLFEEDS (1,000 tons)
1993	7,332
1992	6,944
1991	6,846

Milling of Wheat:

From the grain miller's viewpoint, the single most important wheat quality factor is a high yield of flour with a minimum amount of bran, since the flour is sold at a premium price (54). In general, dark-colored, finely-ground flour has a high bran content; light-colored, coarser-ground flour has a low bran content; flour rich in bran has a low-baking ability. However, after the clinical studies showing benefits of bran in the diet there is demand for a high quality `clear bran' at a premium price. Bran is being used as an ingredient in several foods. A somewhat reduced emphasis is being placed on flour yields, but it is still a major quality factor. White wheat bran contains a higher amount of endosperm is called "heavy bran" and is purchased at a premium price by the breakfast cereal industry.

Wheat Products for Human Foods:

Table 7 contains a list and description of wheat products and their bran contents and their uses as human foods. There are several whole-wheat products such as whole grain wheat, cracked wheat, wheat flakes, wheat grits, and puffed wheat that are essentially various forms of the whole wheat grain still containing the bran. A determination of the availability of these wheat brans containing products to the consumer is discussed in the next section.

Table 7. Wheat Products and Uses for Human Foods (9, 13, 16, 22, 35, 54, 63, 68, 74, 76, 77, 94).

Product(s)	Description	Uses
Whole-grain wheat (wheat berries)	Wheat kernel with the hull removed. Bran still retained on kernel. May be ground into whole wheat flour.	Uses are similar to rice in side dishes, soups, and salads, and desserts and cakes or eaten as a pilaf or morning cereal.
Wheat bran (Miller's bran)	Outer layer of the wheat kernel after the hull is removed.	Unprocessed types (tastes like sawdust) are available to be used on cereals, sprinkled on foods, and added to breads, muffins, etc. Further processed types with added vitamins sugar and flavorings are used in ready-to-eat breakfast cereals.
Wheat flour (many types of wheat flour are available)	Produced by milling wheat from the endosperm or with various amounts of bran depending upon the type of flour specified.	Bread, pastries, cookies, cakes, macaroni. Hard wheat flours include: top patent (used donuts, Danish), first Baker's (all purpose

Product(s)	Description	Uses
	Available as: whole wheat - coarse-textured flour-ground from whole-wheat kernel (may or may not contain bran and germ); graham flour (whole wheat flour with bran layer returned to the flour); white flour (ground endosperm of wheat without bran and germ); bread flour; pastry flour; cake flour; all purpose flour; self-rising flour (baking powder and salt added); semolina flour (from durum wheat); stone-ground flour usually from whole-wheat.	flours for breads, puff pastry), first clears (dark flour used as base for rye bread), second clears (low grade) high ash less than 5% of the milled product, goes to livestock feeds); soft wheat flours include: cake flour (for angel food cakes), pastry flour (cakes, pastries, pies), cookie flour (cookies and blended flours), whole-wheat flour (various bran granulations coarse to fine).
Cracked wheat	Coarsely ground unpolished wheat kernels. Coarse, medium, and fine granulation are available. The bran and germ are still attached.	Used as a cooked cereal, cereals, casseroles, soups, or meat extender.
Wheat flakes (rolled wheat)	Whole wheat (berry) heated and pressed like rolled oats.	Quick cooking form used as a hot breakfast cereal, sprinkled on top of baked goods.
Wheat grits	Whole wheat berry cracked into 6 to 8 separate pieces and includes the bran. Grits are finer than cracked wheat.	Quick cooking breakfast cereal.
Wheat meal	Wheat ground to very fine consistency (may or may not include the bran).	Used as a hot cereal as farina (endosperm with bran removed) also called cream of wheat; wheatina (whole grain) includes the bran; and semolina (endosperm of durum wheat). Used in production of inexpensive pastas.
Puffed wheat	Whole wheat kernel or berry with hull removed that is heated and puffed with air.	Used as a breakfast cereal, or in baked goods and candy.
Shredded whole wheat	Whole wheat manufactured in large biscuits and bite-sized pieces, some add back bran.	In ready-to-eat breakfast cereals.
Wheat germ	Untreated embryo of the wheat kernel removed during milling.	Ready-to-eat raw or toasted and used for breading meats, meat extender and in baked goods. Sprinkle on ready-to-eat cereals, cookies, or desserts.
Bulgur wheat	Whole red or white wheat washed, steamed, hull removed, then parched or dry-cooled, and then	Cooked with meat, baked or fried, used in salads, stuffings, soups, and pilafs.

Product(s)	Description	Uses
	cracked or sifted (fine, medium, and coarse granulations). It is a precooked form of cracked wheat.	

Commercial Availability of Wheat Products to the Consumer:

Whole-wheat berries, wheat bran, bulgur, cracked wheat, wheat flakes, wheat germ, and whole-wheat flour are available from health food stores and mail-order catalogs. Wheat meals (hot cereals), wheat bran, bulgur, cracked wheat, and wheat germ are available in grocery stores cereal and/or cake mix sections. All flours except whole-wheat pastry flour are available through health food or grocery stores. Wheat flakes (rolled wheat) is available from Butte Creek Mill, Eagle Point, OR; graham flour is available from Birkett Mills, Penn Yan, NY and from Kenyon Corn Meal Company, Usquepaugh, RI.

Specific examples of commercial wheat products available at Safeway and Giant Grocery stores in the metropolitan Washington, D.C. area include: `Quaker® Wheat Bran', The Quaker Oats Company PO. Box 9003. Chicago, Il. 60604-9003 , 8 oz (226g) box, serving size 1/3 cup (17g) with ingredients (30g)- Wheat bran: Dietary fiber 8g (7 g insoluble fiber)- 31%. Directions "Suggestions for using as a topping, breading, and cooking. Topping sprinkle a rounded tablespoon over your favorite hot or cold cereal. Sprinkle over tossed salads, soups, sandwiches, fruit, ice cream, or other desserts; breading for crispy chicken or fish coating combine 1/2 cup bran, 2 tablespoons flour, and seasonings. Dip chicken in combined 1/2 cup milk and one egg, coat with bran mixture. For cooking meatloaf combine with beef (1 1/2 lb), bran (1/2 cup, 1 egg, 1/2 cup tomato sauce and seasonings bake 1 hour." Other ready-to-eat breakfast cereals with wheat bran are: `Multi-Bran Chex', Ralston Foods, Inc. P.O. Box 618. St. Louis, MO. serving size 1 1/4 cup (58 g), Dietary fiber 7g (insoluble fiber 6 g, soluble fiber < 1 g) with ingredients are milled yellow corn, wheat bran, rice bran, corn bran, malt syrup.
`Kellogs All Bran' by Kellog's Battle Creek, MI. with wheat and corn bran having 15g dietary fiber, 1g soluble. `Fiber-One' by

General Mills, wheat and corn bran, 13g fiber (7g insoluble, 6g
soluble). Wheat bran is recommended in diets and as part of good nutrition to add one teaspoon bran to foods such as cereals, stews, chili, soups, bread, rice, and muffins (1, 52).

Bran breads are produced by adding $\geq$ 10 kg clean bran/100 kg grain products. Bran enriched from offal (residue of beer production) is also used since the flavor may be preferably to spelty bran (bran with a large % of husk content).

Some of the above uses such as a topping on cereals, salads, and desserts make wheat bran a ready-to-eat food by present Agency policy as described in the June 1995 response to the NFPA petition.

OAT BRAN

The oat kernel, berry, or groat is encased in a hard-fibrous hull that requires vigorous processing to remove it. Oats differ from other grains in two ways: (1) they are mostly used as a whole grain (flour and as a flake), whereas other grains have their germ and a significant portion of bran removed before being used in foods; and (2) oats are heat processed to give them a toasted oat flavor (Table 8). Oat processing for food involves at a minimum step for cleaning, hull removal, steaming, and flaking. Commercial oat mills process 175 kg oats to produce 100 kg food grade oat products. Approximately, 13.5 bushels (432 lb) of oats will yield 180 lb of rolled oats (44, 53). Only high grade oats are used for milling, since > 90% of the oats are fed to livestock, and only 3 % are used in breakfast cereals. Medium quality No. 2 oats yield about 42% rolled oats, 30% hulls, and 28% other products including oat shorts, middlings, bran, and other material removed in the cleaning process (74). Oat hulls are an important industrial by-product because they yield furfural in the manufacture of phenolic resins and solvents.

The oat bran fraction normally remains as part of the whole oat groat. Since endosperm tissues in the oat grain do not separate cleanly from the bran layers, typical oat bran products contain large amounts of adhering starchy endosperm. Oat bran is the bran-rich fraction produced by sieving coarsely ground oat flour. The American Association of Cereal Chemists (100) has defined oat bran as follows:

> "oat bran is the food which is produced by grinding clean oat groats or rolled oats and separating the resulting oat flour by sieving, bolting and/or other suitable means into fractions such that the oat bran fraction is not more than 50% of the starting material, and has a total glucan content of at least 5.5% (dry weight basis) and a total dietary fiber content of at least 16.0% (dry weight basis), and such that at least one-third of the dietary fiber is soluble fiber."

All forms of oat products except some refined oat flours contain some bran. Oatmeals are also mostly a whole grain product. The popularity of oat bran has greatly increased since the findings that it reduces LDL cholesterol (the type associated with fatty artery deposits), and oat bran is the highest source of soluble fiber of the cereal grains (Table 5). Oat bran should be considered as a possible addition to the list of processed foods in Table II, Subdivision O, whenever the latter is updated. The U.S. per capita consumption of all oat food products was 13.1 lb in 1992-1993 (Table 3B). The percent efficiency of milling oats depends on the original quality of the oats and the efficiency of the milling process.

Oat Products for Human Foods:

Table 8 contains a list and description of oat products and their bran contents and their uses as human foods. There are several whole oat groat products such as rolled oats, oat flakes, oatmeal, and steel-cut oats. Oatmeal based breakfast cereal products account for the largest market share (> 66%) of the hot cereal industry (54). A determination of the availability of these oat brans containing products to the consumer is discussed in the next section.

Table 8. Oat Products and Uses for Human Foods (9, 16, 22, 54, 63, 74, 76, 100).

Product(s)	Description	Uses
Rolled oats and Quick-cooking rolled oats	Product from flattening (rolling) oat groats after treating them with steam, and passing the flakes through separators to remove fine particles. Quick-cooking rolled oats are flattened, steamed, and cut. Both may be ground into oat flour. Quaker oatmeal often called "old fashion oats" are rolled oats.	Breakfast foods, cookies, cakes and bread. Sold as oatmeal or quick cooking instant oats. Granola can be homemade or produced commercially as a ready-to-eat cereal or as a snack.
Oat flakes	Product from whole rolled oat groats steamed and rolled and are similar to rolled oats but flakes are slightly thicker, and not as long as steel-cut oats.	Used in porridge, hot cooked.
Oat flour	Produced by grinding and screening the oat flakes from the rolled oat.	Used in baby foods and as an antioxidant. Used up to 14.6% in breads. Used in cereals and ready-to-eat breakfast cereals.

Product(s)	Description	Uses
Oatmeal	Uniform ground oat groats granules cut with to a mealy texture and a minimum of fine granules and flour. Oatmeal is available as coarse, "pinhead" medium, and fine sizes. Instant oatmeals are oats partially cooked and dried before being rolled.	Increasing use as a ready to eat breakfast food. Does not require cooking but is hydrated with boiling water. Also, traditional hot porridge.
Oat bran	Outer covering of the whole oat groat after the hull is removed. Oat bran is the bran-rich fraction produced by sieving coarsely ground oat flour. All forms of oat products except some refined oat flours contain some bran.	Used in cooking bread, waffles, pancakes, muffins, cookies, sprinkled on tops of salads and cereals.
Steel-cut oats (also called Scottish or Irish oats)	Whole oat groats cut into 2 to 3 pieces with steel blades. Used in preparation of flakes and flour.	Used like rolled oats to make porridge or oatmeal, also used in cookies, pancakes, and scones. Takes longer to cook than rolled oats.
Oat groats or whole oat groats	The whole oat grain with the outer husk removed.	Can be cooked whole or ground. Used in salads, stews and baked products.

Commercial Availability of Oat Products to the Consumer:

Most oats for human consumption are marketed as rolled oats. Oat groats, oat flakes, and oat bran are available from health food stores and mail-order catalogs. Irish steel-cut oats are available in health food stores and in some grocery stores and mail order catalogs. Regular rolled oats, quick-cooking rolled oats and instant oatmeal are all available at supermarkets in the breakfast cereal section. Oat bran is available in the ready-to-eat, breakfast cereal section and bakery section of the grocery store and health food stores. Oat flour is available in health food stores. All forms of oat products except some refined oat flours contain naturally some bran.

Specific examples of commercial oat products available at Safeway and Giant Grocery stores in the metropolitan Washington, D.C. area include:

`Mothers' and Quaker oats `Quaker® Oat Bran' by The Quaker Oats Company P.O. Box 9003. Chicago, Il. 60604-9003, with oat bran and contains dietary fiber 6g (3 g soluble and 3g insoluble fiber). Directions to add to muffins, a topping on breads and cereals or cook as a hot cereal. Ready-to-eat breakfast cereals include `Kellog's Common Sense Oat Bran Cereal', Battle Creek, MI contains "oat bran, whole wheat" (dietary fiber 4g -1g soluble, and 3g insoluble); `Quaker Oat Squares' Quaker Oats Company PO. Box 9003. Chicago, Il. 60604-9003, ingredients include whole oat grain (with oat bran) and malted barley extract; `Quaker Multi-grain Oatmeal' contains natural rye, rolled rye, barley, oats, (dietary fiber 5g); `Instant Quaker Oatmeal' contains whole grain rolled oats (with oat bran) and dietary fiber 3g with 1g soluble fiber; `Frosted Cheerios' by General Mills Inc. Minneapolis, MN 55400 with ingredient whole oat flour (includes oat bran) dietary fiber 1g. It is recommended to add one teaspoon of oat bran to foods such as cereals, stews, chili, soups, bread, rice, and muffins (1, 52).

The use of oat bran as a topping on breads and cereals results in the processed commodity being considered a ready-to-eat food.

BARLEY BRAN

Barley kernel is like oats in that it is harvested with the hull intact. Barley contains 10 - 16% bran, 82 - 88% endosperm, and 2 - 3% embryo (Table 4). Traditionally, unpearled barley is not roller-milled as are wheat and oats to make flour and bran (15, 51). If necessary barley can be milled with the same equipment used to mill wheat. True barley bran is whiter than oat bran, and Dr. Bhatty (7,8) states that barley bran has the same potential to increase in use as was the case with oat bran. Barley is usually milled with abrasive disks to remove the hull and bran. The milling steps are referred to as pearlings. The first pearling produces pot barley, followed by three more pearlings to produce pearl barley (small white grains of uniform size with the embryo removed). True barley bran and flour have not been fully produced and investigated. Barley bran, unlike wheat bran is brittle and shatters. In the regular pearling process, bran is lost and mixed with hulls for use as an animal feed.

Most barley flour is now obtained by milling pot or pearled barley and in some cases brewer's spent grain (BSG) is milled to produce barley bran. Hulless barley cultivars dry-milled had the following yields: flour - 74%, shorts - 15 %, and bran - 11%. Flour yields for barley range from 61 - 74%, with the bran + shorts yielding 26 to 39 % (7). Approximately, 100 lb of barley will mill to 65 lb pot barley and 35 lb pearl barley.

Research on barley as a soluble fiber source in the diet to lower cholesterol has just begun (3). Barley bran with 40% soluble fiber has been found to lower cholesterol and the risk of colon cancer (56, 58). The residue from barley grain that has been malted includes brewer's spent grains (BSG) and distiller's dried grains (DDG) that are high in fiber, and used as a source of bran in commercial cooking. The bran obtained from milling BSG is used commercially in various bakery products like cookies, bread, and cakes (51). The potential use of barley as a source of soluble fiber may encourage more conventional roller-milling of barley (8). Use of dry milled true barley bran in various food products still needs developmental research.

Only 5% of the barley crop in the U.S. is used directly as a human food, since 52.8% is used for feed or seed and the other 42.2% is used for malting in the production of beer (Table 1). Of the > 3.3 million metric tons of barley malted, 93.6% were utilized for brewer's malt, 1.2% for distiller's malt, and 5.2% utilized for food malts (82).

Brewer's spent grain (BSG) composed of barley hulls and pericarp (bran) are separated after milling (15). The hulls are too fibrous and abrasive in texture to be usable as a human food. In brewing, a mash is prepared from water, malt, and a cooked carbohydrate adjunct like corn grits or rice. The mash is heated and an enzymatic hydrolysis is completed that leaves a liquid (wort) to brew beer and a solid residue. Brewers' spent grains (BSG) are the solid barley residue by-product that remains after filtration (64). For every barrel of beer, 12 1/2 lbs (dry wt) of BSG are produced, and more than 700,000 tons (dry wt) of BSG are produced annually in the U.S. The spent grain consists mainly of the pericarp (bran) and hull portions of barley and nonstarchy parts of corn if corn grits were used as an adjunct. The BSG is still high in fiber and protein after milling and can be added to human foods (7). Formula for bread was 100 g flour (14% mb) and 15 g of BSG (14% mb) to replace 15 g of flour (18). BSG consists of two widely different fractions: hulls with large particle size that are fibrous and abrasive in texture, and a dark brown barley pericarp with smaller, softer texture and high in bran.

Barley Products for Human Foods:

Table 9 contains a list and description of barley products and their bran contents and their uses as human foods. Almost all barley products except for barley groats available for human food use have most of their bran layer removed. A determination of the availability of these barleys and its bran containing products to the consumer is discussed in the next section.

Table 9. Barley Products and Uses for Human Foods (7, 9, 16, 15, 18, 22, 26, 55, 57, 62, 63).

Product(s)	Description	Uses
Pot Barley (also called Scotch or hulled barley)	Kernel following three pearlings with the hull removed and most of the bran removed. Darker in color than pearl barley.	Soups, stews, vegetable dishes
Pearl or pearled brley	Remaining kernel after 2 to 3 additional pearlings, followed by sizing, embryo is removed and >97% bran is removed. Available in fine, medium, and coarse sizes.	Most common form of barley in the U.S. Same as pot barley substituted for rice in puddings, casseroles, porridge. Highly digestible.
Barley flour	Two types: (1) coarse flour milled from barley groats contains bran. (2) patent barley flour highly refined from pearled barley contains <3% bran.	Used in quick rising doughs to make biscuits, muffins, and pancakes (can substitute for up to 25% of whole-wheat flour in baking). Baby foods. Used in products for people with wheat intolerances.
Infant cereals	Made from coarse barley flour dehulled.	More nutritious than ready to eat breakfast cereals for children and adults.
Barley groats	Kernels which have outer hulls and seedcoats removed	Crushed and used in porridge.
Barley grits	Pot barley that is toasted and broken into 5 or 6 pieces.	Cook as an cooked cereal like oatmeal, much like hominy grits, and used in puddings.
Barley flakes (Rolled barley)	Barley groats as pearl barley toasted, soaked steamed and rolled like rolled oats.	Used as a hot breakfast cereal in other countries not in the U.S. Can be used to mix in foods like meat loafs or as a thickening agent in soups, stews, baked goods.
Malted barley cereals	Cooked and ready to eat cereals that contain malted barley that is coarsely ground and toasted.	Used in several cereals, and used in muffins, pancakes.
Barley malt	From germinating (sprouting) barley, followed by drying and removing the sprouts, and grinding into a powder.	Malts for brewers and distillers, special bread flours, and malted milk. Not as sweet as honey.
Hulless barley	Barley cultivated without a lightly adherent hull, and does not require polishings. Dark brown in color.	Use similar to pot barley. Used for cooking and sprouting.
Brewer's spent grains (BSG)	Barley grain byproduct left after mashing operation for beer making that is dried and milled to produce flour and bran.	Used commercially to make hread, cakes, and cookies.

Product(s)	Description	Uses
Beer	Barley is malted and brewed; major use (42%) of barley.	Beer.

Commercial Availability of Barley to the Consumer:

Pearl barley (including quick cooking types) is available from grocery stores in their dried bean and rice sections, health food stores and mail-order catalogs. Pot barley, hulless barley, barley grits, barley flakes, rolled barley, and barley flour are available through health food stores and mail-order catalogs. Barley malt can be found in health food stores. According to Dr. Ory (66), barley bran is not yet a major source of dietary fiber because of its lack of continuous availability.

Specific examples of barley products available at Safeway and/or Giant Grocery stores in the metropolitan Washington, D.C. area include: `Scotch Brand Quick Pearled Quaker Barley' by The Quaker Oats Company, P.O. Box 9003, Chicago, Il 60604-9003, with 1.7 oz. serving contains 5.0g dietary fiber. Wasa® Crispbreads Sweden', imported by Liberty Richter, Saddlebrook, NJ. 07663 contains whole grain rye flour, yeast, salt (dietary fiber 2g serving, 14g - 45 calories); `Puffed Kashi, by Kashi Co., P.O. Box 8557, LaJolla, CA 92038, contains 7 whole grains including whole barley with dietary fiber at 2g.`Quaker Multi-Grain Oatmeal' contains natural rye, rolled rye, barley, oats (dietary fiber 5g).

Barley bran in its pure form is not available to consumers. Based on its use in commercial baked goods it should be considered a not ready-to-eat food. Information on its maximum level in such foods is not readily available, but it is reasonable to assume it would not comprise more than 50%. Therefore, the dilution factor is at least 2X.

RYE BRAN

When grains were ground with millstones, wheat and rye mills were identical. After roller mills and middling purifiers were developed, some milling operations now differ. The milling of rye is still basically similar to wheat except for two main differences: (1) the endosperm of rye has a tendency to flake and break up into flour fineness more readily than wheat endosperm; and therefore, (2) separation of the endosperm from the bran of rye is more difficult since the bran adheres tenaciously to the endosperm and the middling fraction is extremely hard to purify into distinct fractions (12, 74, 94). Rye milling in Denmark (67) produces up to 15 separate fractions. In the U.S., most of the rye received from farmers by grain elevators is cleaned, graded, and stored at a moisture $\leq$ 13% and mixed with various lots for uniformity and for sale to millers to meet their requirements. Arrowhead Mills in Hereford, Texas, produces many specialty cereal crop flours and brans that are widely available in health food stores and major grocery stores. However, according to Mr. L. Hendershall, Manager of Arrowhead Mills Technical Services (31), rye bran is not produced as a commodity for human use, but whole rye grain (which contains the bran) coarsely ground is produced and is sold for use in breads and baking. Dr. John Hillman, Manager, Bay State Milling Co. Quincy, MA (33) stated that the rye bran can be produced, but the sales market is presently too small to provide an economic impetus to produce it. Specialized rye flours and bran mixtures are sold directly to the bakery. Often the customer and/or bakery specifies the blend and grind they need for their baking purposes. Light brown rye kernels are usually preferred for flour, since the bran layer is thinner than in darker kernels and gives higher flour yields. Although rarely produced as a distinct commodity, rye bran is cheaper than wheat bran, but wheat bran is plentiful and readily accessible. Greater than 90% of the rye bran and rye byproducts are utilized in animal feeds (dog and livestock). In milling rye, unlike wheat, no effort is made to remove the bran particles from the middlings as they come over the sifters and no purifiers are used. Major rye mills in the U.S. are two Conagra mills and the Bay State Milling Co. The daily U.S. grind for rye flour is <10,000 hundreds wts, while ground wheat flour is >1 million hundred wts/day (12).

Most of the flour used to make rye breads are baked using a mixture of rye and wheat flour. Mills will market rye blends from mixtures of spring or hard red winter wheat and rye such as 80% clear wheat flour and 20% dark rye; 70% clear wheat flour and 30% white rye flour; and 50% clear flour and 50% white rye. Approximately 20% of the rye flour milling are byproducts which includes the bran and middlings fractions, for a total of 2,000 hundred wts/day. In milling rye for flour the yields for white rye flour (0.60 - 0.70% ash) accounts for 65 - 80% of the rye flour produced, with dark rye flour (2.25 - 3.00% ash) accounting for 15 - 20 %, and offals for animal feed accounting for 15 - 20 % (9). Approximately 2.23 bu. (125 lb) rye grain will give a milling yield of 100 lb rye flour (25). Depending on the milling process the equivalent of 20 lb rye bran are separated out during milling from one bushel of rye (56 lb/bu).

Table 10. Rye Products and Uses for Human Foods (9, 12, 16, 22, 26, 26, 63, 64, 74, 79).

Product(s)	Description	Uses
Rye (whole-grain rye)	Ground, dry whole rye grain with outer hull removed (100% whole grain rye flour).	Ryecrisp bread (like a flat cracker).
Rye flakes or rolled rye	Rolled whole rye, after steaming and flattening between steel rollers.	Used as a hot cooked cereal or porridge, also soaked and used as a bread topping.
Rye flour	Produced by milling rye like wheat. Sold as light or white (patent flour from the rye kernel used in light colored rye breads), medium (flour from the whole rye kernel with the bran removed), and dark or pumpernickel (contains 100% of the grain). Darker flours contain the most bran. Ground into a finer consistency than rye meal. Available health food stores.	In U.S. rye bread is made as a combination of rye and wheat flour. Biscuits and crackers have 10% rye flour and 90% wheat flour. Used in pancakes and sourdough rolls. Consumers prefer rye-flour rolls with only small portions of rye flour content (<30%), while in other countries up to 90% rye flour mixture with wheat flour is utilized.
Rye grits (cracked rye)	Whole rye cracked into 6 to 8 separate pieces, cracked unpolished kernels slightly sour taste with a soft texture (available in fine/medium/coarse granulations).	Used as a cooked cereal (cream of rye) or mixed with other grains for bread flour.
Rye meal	Rye ground to consistency of cornmeal.	Used as a blend with other flours before baking.
Whole grain rye or rye berry.	Cleaned intact whole grain with just outer hull removed.	Used as a mash containing ≥ 50% rye, used like cooked pot barley in soups or stews, or sprouted and used in soups and salads, or may be ground into rye flour. Can be puffed and used in ready-to-eat cereal `Kashi'.

Commercial Availability of Rye to the Consumer

Whole-grain rye, rye grits, rye meal, rye flour, and rye flakes are available from health food stores and mail-order catalogs. Rye flour (especially light and medium) can now also be found at supermarkets. Rye bran is not sold for consumer use as a separate product unless it is special ordered and normally rye bran is sold mixed with other rye feedstuffs as an animal feedstuff. Rye bran is a natural component of whole grain rye, rye flakes, medium and dark whole rye flour, rye grits and meal. Whole rye berries, cracked rye, and rolled rye are available from mailorder catalogs such as Butte Creek Mill, Eagle Point, OR. A retail pack of a coarse rye meal labeled `Cream of Rye' that is used like oatmeal is available in a few health food outlets.

Specific examples of commercial rye products available at Safeway and Giant Grocery stores in the metropolitan Washington, D.C. area include: `Wasa® Crispbreads Sweden', imported by Liberty Richter, Saddlebrook, NJ. 07663 contains whole grain rye flour, yeast, salt (dietary fiber 2g serving, 14g - 45 calories); `Quaker Multi-Grain Oatmeal' contains natural rye, rolled rye, barley, oats (dietary fiber 5g); `Puffed Kashi, by Kashi Co., P.O. Box 8557, LaJolla, CA 92038, contains 7 whole grains including whole rye with dietary fiber at 2g.

Based on the very limited availability as a human food, we conclude that pesticide tolerances should not be necessary on rye bran as a distinct commodity. As presently marketed and consumed in the U.S., it is a not ready-to-eat food. Similarly, to barley bran, it would be diluted at least 2X when used in preparation of other foods.

cc: RF, circu, SF, R. Loranger, Bran Commodity File
RDI: RAL: 2/12/96: EZager: 2/12/96
7509C:RM:804V:CM#2: BAS:305-5555:1/25/96
File: BRANRTE2.

REFERENCES

1.Alabaster, O. and J. Jibrin. 1993. The Bran Plan Diet. Rodale Press. Emmaus, PA. 278 pp.

2.Anderson, K.N. and L.E. Anderson. 1993. The International Dictionary of Food and Nutrition. John Wiley & Sons. NY. 330 pp.

3.Ash, M.S. 1992. Animal Feeds Compendium. USDA Economic Research Service Report No. 656. 158 pp.

4.Berglund, P.T., C.E. Fastnaught, and E.T. Holm. 1994. Physicochemical and Sensory Evaluation of Extruded High-fiber Barley Cereals. Cereal Chemistry 71(1): 91-95.

5.Bhatty, R.S. 1986. The Potential of Hulless Barley - A Review. Cereal Chemistry 63(2):97-103.

6.Bhatty, R.S. 1992. Beta-Glucan Content of Barley and Their Rolled Wheat Flour and Bran Products. Cereal Chemistry 69(5):469-471.

7.Bhatty, R.S. 1993. Physicochemical Properties of Roller-milled Barley Bran and Flour. Cereal Chemistry 70:397-402. (59.8.C33).

8.Bhatty, R.S. 1995. Promotion of Hulless Barley in Food and Industry. Project ID: 85020054. University of Saskatchewan Crop Development Center. Saskatoon, Canada. USDA Current Research Information Service (CRIS).

9.Blanck, F. 1955. Cereal and Cereal Products. Pp. 411-452 In Handbook of Food and Agriculture. Reinhold Publ. Co. NY.

10.Boyles, S.L., V. Anderson, and K. Koch. 1992. Feeding Barley to Cattle. North Dakota State Univ. Extension Service pp. 3-14.

11.Burge, R.M. and W.J. Duensing. 1989. Processing and Dietary Fiber Ingredient Application of Corn Bran. Cereal Foods World 34:535.

12.Bushuk, W. 1976. Rye: Production, Chemistry, and Technology. American Association of Cereal Chemists. St. Paul, MN. 181 pp.

13.Bushuk, W. and V.F. Rasper. 1994. Wheat: Production, Properties, and Quality. Chapman & Hall. Great Britain. 238 pp.

14.Camire, M.E., J. Zhao, M.P. Dougherty, and R.J. Bushway. 1995. In Vitro Binding of Benzo(a)pyrene by Ready-to-Eat Breakfast Cereals. Cereal Food World 40(6): 447-450.

15.Dreese, P.C. and R.C. Hoseney. 1981. Baking Properties of the Bran Fraction from Brewer's Spent Grains. Cereal Chem 59(2):89-91.

16.Ensminger, A.H., M.E. Ensminger, J.E. Konlande, and J. Robson. 1995. The Concise Encyclopedia of Foods and Nutrition. CRC Press. First Ed. Boca Raton. 1178 pp.

17. Fast, R., G. Laudhoff, D. Taylor, and S. Getwood. 1990. Flaking Ready- to-Eat Breakfast Cereals. Cereal Foods World 35(3): 295-296, 298.

18.Fedak, G. 1994. Barley. Pp. 233-251 In Encyclopedia of Agricultural Science. Vol. I, A-D. Academic Press, NY.

19.Finley, W. and W. Hanamoto. 1980. Milling Barley and Properties of Dried Brewers Spent Grains. Cereal Chemistry 57:166.

20.Gaines, R.L., D.B. Bechtel, and Y. Pomeranz. 1985. A microscopic Study on the Development of a Layer in Barley that Causes hull-caryopsis Adherence. Cereal Chemistry 62(1):35-40.

21.Gan, Z., T. Galliard, P.R. Ellis, R.E. Angold, and J.G. Vaughan. 1992. Effect of the Outer Bran Layers on the Loaf Volume of Wheat Bread. J. Cereal Chemistry 15(2): 151-163.

22.Gelles, C. 1989. The Complete Whole Grain Cookbook. Donald I. Fine, Inc., NY. 514 pp.

23.Gordon, B. and C. Willm. 1994. Primary Cereal Processing. A Comprehensive Source. VCH Publ. NY. 544 pp.

24.Greene, B. 1988. The Grains Cookbook. Workman Publ., NY. 403 pp.

25.Hall, C.W. and D.C. Davis. 1979. Processing Equipment for Agricultural Products. Second Ed. AVI Publishing Co., Westport, CT.

26.Hartzell, G. 1995. Grain Varieties are the Spice of Life for Many New Food Products. Minnesota Grain Pearling Company. P.O. Box 545. Cannon Falls, MN 55009.

27.Hashimoto, S., M.D. Shogren, L.C. Bolte, Y. Pomeranz. 1987. Cereal Pentosans: Their estimation and Significance. III. Pentosans in Abraded Grains and Milling Byproducts. Cereal Chemistry 64(1):39-41.

28.Hatcher, D.W. and J.E. Kruger. 1993. Distribution of Polyphenol Oxidase in Flour Millstreams of Canadian Common Wheat Classes Milled to Three Extraction Rates. Cereal Chemistry 70(1): 51-55.

29.Hayes, J.L. and B.T. Leblng. 1992. Grains. Harmony Books, NY. Pp. 4-14.

30.Haynos, R.R. 1985. Improved Method for Extraction of Light Filth from 90% Rye Bran Crisp Bread. J. Assoc. Off. Anal. Chem. 68(1): 17-19.

31.Hendershall, L. 1995. Manager Technical Services. Arrowhead Mills Hereford, Texas. Phone call to Dr. B.A. Schneider, USEPA, 11/25/95). (806-364-0730).

32.Henwood, R. 1995. Millers' National Federation. Washington, DC. 202-484-2200.

33.Hillman, J. 1995. Manager, Bay State Milling Co. Quincy, MA. Phone call to Dr. B.A. Schneider, USEPA, 12/5/95). (617-328-6573).

34.Holcomb, D. 1995. International Grain Products. P.O. Box 677. Wayzata, MN. (612-474-6573).

35.Hoseney, R.C. 1986. Principles of Cereal Science and Technology. American Association of Cereal Chemists. St. Paul, MN. 327 pp.

36.Hudson, C.A., M.M. Chiu, and B.E. Knuckles. 1992. Development and Characteristics of High-Fiber Muffins with Oat Bran, Rice Bran, or Barley Fiber Fractions. Cereal Foods World 37:373-377.

37.Hundemer, J.K., S.P. Nabar, B.J. Shriver, and L.P. Forman. 1991. Dietary Fiber Sources Lower Blood Cholesterol in C57BL/6 Mice. J. Nutrition 121(9): 1360-1365.

38.Jenkins, B. 1990. Wheat Facts 1990. The Wheat Grower 13(7): Supplement.

39.Kent, N.L. and A.D. Evers. 1994. Kent's Technology of Cereals. Fourth Ed. 334 pp. Pergamon. Elsevier Science Ltd., NY. (TS2145.K36.1994).

40.Knight, J. and C.A. Salter. 1987. Knight's Foodservice Dictionary. CRI Book Publ. Van Nostrand Publ., NY (TX905.K62).

41.Knox, G.M. 1984. Better Homes and Gardens. Cooking With Whole Grains. Meredith Corp., Des Moines, IA. 96 pp.

42.Kohlway, D.E., J.H. Kendall, and R.B. Mohindra. 1995. Using the Physical Properties of Rice as a Guide to Formulation. Cereal Foods World 40(10): 728-732.

43.Larsson, M. and A.S. Sandberg. 1991. Phytate Reduction in Bread Containing Oat Flour, Oat Bran or Rye Bran. J. Cereal Science 14:141-149.

44.Leonard, W.H. and J.H. Martin. 1963. Cereal Crops. Macmillan. NY. First Ed. 824 pp.

45.Liebman, B. 1988. Jumping on the Branwagon. Nutr. Action Health Letter 15(10):10.

46.Lloyd-James, B.D. 1990. Cereal Quality II. Aspects Applied Biology 25:15-18.

47.London, S. and M. London. 1992. The Versatile Grain and the Elegant Bean. Simon & Schuster, NY. 530 pp.

48.Lottie, R.F. 1994. Comments on Table II to J. Stokes, USEPS. August 19. American Oat Association. Minneapolis, MN. 55426.

49.Lupton, J.R., J. Morin, and M. Robinson. 1993. Barley Bran Flour Accelerates Gastrointestinal Transit Time. J. Am. Dietetic Association 93(8): 881-885.

50.Lupton, J.R., M. Robinson, and J. Morin. 1994. Cholesterol-lowering Effect of Barley Bran Flour and Oil. J. Am. Dietetic Association 94(1): 65-70.

51.MacGregor, A.W. and R.S. Bhatty. 1993. Barley: Chemistry and Technology. American Association of Cereal Chemists. St.Paul, MN. 486 pp.

52.Margen, S. 1992. University of California at Berkeley. The Wellness Encyclopedia of Food and Nutrition. University of CA. Rebus Publ. NY. 512 pp.

53.Martin, J., W. Leonard, and D. Stump. 1975,. Principles of Field Crop Production. Third Ed. Macmillan Publ. Co., NY. 1118 pp.

54.Matz, S.A. 1991. The Chemistry and Technology of Cereals as Food and Feed. Second Ed. AVI Book, VanNostrand Reinhold, NY. 751 pp.

55.McGee, H. 1984. On Food and Cooking. Pp. 232-242. Charles Scribner's Sons. NY.

56.McIntosh, G.H. 1993. Colon Cancer: Dietary Modifications Required for a Balanced Protective Diet. Preventive Medicine 22 (5):767-774

57.McIntosh, G.H., R.K. Leleu, A. Kerry, and M. Goldring. 1993. Barley Grain for Human Food Use. Food Australian 45(8):392-394.

58.McIntosh, G.H. 1993. The Potential of an Insoluble Dietary Fiber-rich Source from Barley to Protect from DMH-induced Intestinal Tumors in Rats. Nutr. Cancer 19(2):213-221.

59.Meredith, P. and Y. Pomeranz. 1985. Sprouted Grain. Adv. Cereal Sci. Technology 7:239-320.

60.Morse, D. and S.L. Boyles. 1992. Use of Barley in Diets Formulated for Dairy Cows. North Dakota State Univ. Extension Service pp. 15-18 (S544.3.N9C46).

61.Mullin, W.J. and J. Emery. 1992. Determination of Alkylresorcinols in Cereal-Based Foods. J. Agric. Food Chem. 40(11):2127-2130.

62.Newman, R.K. and C.W. Newman. 1991. Barley as a Food Grain. Cereal Foods World 36(9): 800-805.

63.Olney, R. 1982. Dried Beans and Grains. Time-Life Books. Alexandria, VA. 176 pp.

64.Olson, R.A. and K.J. Frey. 1987. Nutritional Quality of Cereal Grains: Genetic and Agronomic Improvement. American Society of Agronomy. Monograph Number 28. First Ed., Madison, WI. 522 pp.

65.Oelke, E.A., E.S. Oplinger, H. Bahri, B.R. Durgan, D.H. Putnam, J.D. Doll, K.A. Kelling. 1990. Rye. IN University of Wisconsin and Minnesota Alternatives Field Crops Manual. No. 141 St. Paul, MN.

66.Ory, R.L. 1991. Grandma Called It Roughage. Fiber Facts and Fallacies. America Chemical Society. Washington, DC. 165 pp.

67.Pedersen, B. and B.O. Eggum. 1983. The Influence of Milling on the Nutritive Value of Flour from Cereal Grains. I. Rye. Qual. Plantas Plant Foods Human Nutrition 32(2):185-196.

68.Pedersen, B. and B.O. Eggum. 1983. The Influence of Milling on the Nutritive Value of Flour from Cereal Grains. II. Wheat. Qual. Plantas Plant Foods Human Nutrition 33(1):51-61.

69.Pedersen, B. and B.O. Eggum. 1983. The Influence of Milling on the Nutritive Value of Flour from Cereal Grains. III. Barley. Qual. Plantas Plant Foods Human Nutrition 33(1):99-112.

70.Petersen, D.M. 1994. Barley Tocols: Effects of Milling, Malting, and Mashing. Cereal Chem. 71(1):42-44.

71.Pointillart, A. 1991. Enhancement of Phosphorus Utilization in Growing Pigs Fed Phylate-rich Diets by Using Rye Bran. J. Animal Sci. 69(3):1109-1115.

72.Pollack, L.M. and P.J. White. 1995. Corn as a Food Source in the United States: Part I: Historical and Current perspectives. Cereal Foods World 40(10): 749-754.

73.Pomeranz, Y. 1983. Grain Endosperm Structure and End-use Properties. Dev. Food Sci. 5A:19-48.

74.Pomeranz, Y. 1987. Modern Cereal Science and Technology. First Ed. VCH Publ., Inc. 486 pp.

75.Pomeranz, Y. 1987. Food Analysis: Theory and Practice. Second Edition. 797 pp.

76.Pomeranz, Y. 1988. Wheat: Chemistry and Technology. Volume I. Third Ed. American Association of Cereal Chemists. St. Paul, MN. 512 pp.

77.Pomeranz, Y. 1988. Wheat: Chemistry and Technology. Volume II. Third Ed. American Association of Cereal Chemists. St. Paul, MN. 562 pp.

78.Pomeranz, Y. 1989. Wheat is Unique: Structure, Composition, Processing, and End-use Properties and Products. Wheat Industry Utilization Conference, 1988. San Diego, CA.

79.Pomeranz, Y. 1991. Functional Properties of Food Components. Second Ed. 569 pp.

80.Pratley, J. 1994. Principles of Field Crop Production. Third Ed. Oxford Univ. Press, NY. 502 pp.

81.Ranhotra, G., J. Gelroth, K. Astroth, and E. Posner. 1990. Distribution of Total and Soluble Fiber in Various Millstreams of Wheat. J.Food Sci. Off. Publ. Inst. Food Technol. 55(5):1349-1351

82.Rasmusson, D.C. 1985. Barley. American Society of Agronomy. Monograph Number 26. First Ed., Madison, WI. 522 pp.

83.Riche, M. 1994. 1992 Census of Agricultural. Volume 1. Geographic Area Series. Part 51: United States Summary and State Data. U.S. Department of Commerce. Bureau of the Census. AC92-A-51.

84.Roetenberg, K. 1995. Fundamentals of Drying Breakfast Cereals. Cereal Foods World 40(6):428-426.

85.Rokey, G.J. 1995. RTE Breakfast Cereal Flake Extrusion. Cereal Foods World 40(6):422-415.

86.Sauer, D. 1992. Storage of Cereal Grains and Their Products. Fourth Ed. American Association of Cereal Chemists. St. Paul, MN. 615 pp.

87.Schneider, B.A. 1995. Additional Information on Wheat and Other Small Grains as Hay Crops. USEPA. Feb.8.

88.Schunemann, C. and G. Treu. 1988. Baking. The Art and Science. Baker Technology, Inc. Calgary, Canada. 336 pp.

89.Sundberg, B. and P. Aman. 1994. Fractionation of Different Types of Barley By Roller Milling and Sieving. J. Cereal Sci. 19:179-184.

90.Takano, K. 1993. Advances in Cereal Chemistry and Technology in Japan. Cereal Foods World 38(9): 695-698.

91.USDA. 1994. Agricultural Statistics. National Agricultural Statistics Service. U.S. Government Printing Office. Washington, DC. 486 pp.

92.USDA. 1995. Current Research Information System. (CRIS) USDA National Agricultural Library.

93.Vollendorf, N. and J. Marlett. 1991. Dietary Fiber Methodology and Composition of Oat Groats, Bran, and Hulls. Cereals Foods World 36(7):565-570.

94.Weber, F.E., W. Feldhum, Y. Pomeranz, and F. Meuser. 1985. Chapter 4, Pp. 169-238 In Pomeranz, V., Editor. Advances in Cereal Science and Technology Vol. 7. American Association Cereal Chemists, St. Paul, MN.

95.Webster, F.H. 1986. Oats: Chemistry and Technology. American Association of Cereal Chemists. St.Paul, MN. 430 pp.

96.White, P.J. and L.M. Pollack. 1995. Corn as a Food Source in the United States: Part II: Processes, Products, Composition, and Nutritive Values. Cereal Foods World 40(10): 755-762.

97.Wikstrom, K., L. Lindahl, R. Andersson, and E. Westerlund. 1994. Rheological Studies of Water-soluble (1,3), (1-4)-beta-D-glucans from Milling Fractions of Oat. J. Food Sci. 59(5): 1077-1080

98.Wingfield, J. 1989. Dictionary of Milling Terms and Equipment. Association of Operative Millers. Manhattan, KS. 331 pp.

99.Wolfe, I.A. 1982. Handbook of Processing and Utilization in Agriculture. Volume II. Part I. Plant Products. CRC Press. Boca Raton, FL. 727 pp.

100.Wood, P. 1993. Oat Bran. First Ed. American Association of Cereal Chemists. St. Paul, MN. 164 pp.

101.Woollen, A. 1969. Food Industries Manual. 20th Ed. Chemical Publishing Co, NY.

102.Young, K.B. 1991. Prospects for Increasing Returns from Rice Bran and other Rice milling by-products. Univ. Arkansas Agri. Experiment Station Special Report No. 152.

APPENDIX I: U.S. Production of Wheat, Oats, Barley, and Rye (3, 91).

WHEAT

Year	Wheat Grain Production (1,000 bushel)	Domestic Use-Food (Million Bushels)	Domestic Use-Feed (Million Bushels)	Domestic Use - Seed (Million Bushels)	Domestic Use - Total (Million Bu.)	Exports (Million Bushels)
1993	2,402	869	276	95	1,241	1228
1992	2,459	834	186	98	1,118	1354
1991	1,981	789	276	98	1,134	1282

** A bushel of Wheat is 60 lbs.

The three main types of wheat grown for grain are Winter wheat- 73.4%; Spring wheat - 23.6%; and Durum wheat- 2.9%. Sources: Ag. Stats Tables 2, 3, 5, 12, 28, 69. AgCensus 1992- Table 26; Mautz (p35).

OAT:

Year	Oat Grain Production (Million Bushels)	Domestic Use- Food and Seed (Million Bushels)	Domestic Use- Feed and Residual (Million Bushels)	Domestic Use – Total (Million Bushels)	Exports - (Million Bu.)*
1993	206	125	193	318	25
1992	295	125	234	359	14
1991	243	125	235	360	53

BARLEY

Year	Barley Grain Production (1,000 bushel)	Domestic Use- Feed & Residual (Million Bushels)	Domestic Use - Food, Alcohol, and Seed (Million Bushels)*	Domestic Use - Total (Million Bu.)	Exports (Million Bushels)
1994	375,318	215	175	390	60
1993	398,041	244	175	419	66
1992	455,090	195	172	366	80
1991	464,326	225	176	401	94

* Barley for seed averages 13 million bushels/yr.
** A bushel of barley is 48 lbs.

RYE

Year	Rye Grain Production (1,000 bushel)	Domestic Use- Food (Million Bushels)	Domestic Use- Feed (Million Bushels)	Domestic Use - Seed (Million Bushels)	Domestic Use - Total (Million Bu.)*	Exports (Million Bushels)
1993	10,340	3,500	6,199	3,000	14,699	25
1992	11,952	3,500	6,496	3,000	14.996	14
1991	9,761	3,500	7,563	3,000	16,063	53

* Approximately 2,000,000 bushels are used for industrial purposes (nonfeed use).
** A bushel of Rye is 56 lbs.

CODEX CLASSIFICATION OF PROPOSED COMMODITIES AND EPA FOOD AND FEED COMMODITY VOCABULARY: See Table 31. Comparisons of Legume Vegetable Crop Group 6 with the Legume Vegetables Codex group (014, Code VP) and Pulses group (015, Code VD). (Data prepared by Dr's. Yuen-Shaung NG, Bernard A. Schneider, US EPA November 9, 2017).

An important aspect of developing this revised crop group was harmonization with the Codex Crop Classification of Foods and Animal Feeds. The original 1993 Codex classification system is currently under revision and revisions to the US system are used as a basis for the Codex revision. The IR-4/EPA Crop Grouping Working Group and the ICGCC collaborates with the revision of the Codex crop classification. Bill Barney is the Chairperson of the Codex Classification of Food and Feed Committee. The Codex Classification of Foods and Animal Feeds includes cereal grains in Group 020, Cereal Grains (see Table 1), while straw, fodder and fodder of cereal grains are included in the old group Group 051, Straw, fodder and forage of cereal grains and grasses, except grasses for sugar production (including buckwheat fodder). Codex uses multiple commodity terms for the same commodity and refers to the preferred commodity, while EPA has the Food and Feed Commodity Vocabulary website that has many lookup terms that link to the preferred commodity term used for establishing tolerances/MRL (**Table 31**).

Table 31. CODEX CLASSIFICATION OF PROPOSED CEREAL GRAIN COMMODIIES AND THE EPA FOOD AND FEED VOCABULARY FOR PROPOSED CEREAL GRAIN CROP GROUPS 15 and 16 (Based on NG and Schneider, 2017).

LETTER	Number	CODEX	EPA PREFER	Proposed EPA Crop Group	EPA Crop Group
GC	3080	Amaranth, grain	Amaranth, grain	15	Grain, cereal, group 15
GC	2090	Baby corn	Baby corn	15	Grain, cereal, group 15
GC	0640	Barley	Barley	15	Grain, cereal, group 15
GC	0641	Buckwheat	Buckwheat	15	Grain, cereal, group 15
GC	3085	Buckwheat, tartary	Buckwheat, tartary	15	Grain, cereal, group 15
GC	3087	Canarygrass, annual	Canarygrass, annual	15	Grain, cereal, group 15
GC	0642	Canihu	Canihu	15	Grain, cereal, group 15
GC	3081	Chia	Chia	15	Grain, cereal, group 15
GC	2089	Corn-on-the-cob	Corn, sweet	15	Grain, cereal, group 15
GC	3082	Cram-cram	Cram-cram	15	Grain, cereal, group 15
GC	0643	Hungry rice	Fonio, black Fonio, white	15	Grain, cereal, group 15
GC	3083	Huauzontle	Huauzontle, grain	15	Grain, cereal, group 15
GC	0644	Job's tears	Job's tears	15	Grain, cereal, group 15
GC	0645	Maize	Corn, field	15	Grain, cereal, group 15
GC	0646	Millet	Millet, proso	15	Grain, cereal, group 15
GC	0647	Oats	Oat	15	Grain, cereal, group

LETTER	Number	CODEX	EPA PREFER	Proposed EPA Crop Group	EPA Crop Group
					15
GC	0656	Popcorn	Popcorn	15	Grain, cereal, group 15
GC	3084	Psyllium sp.	Psyllium and Psyllium, blond	15	Grain, cereal, group 15
GC	0648	Quinoa	Quinoa	15	Grain, cereal, group 15
GC	0649	Rice	Rice	15	Grain, cereal, group 15
GC	308	Rice, African	Rice, African	15	Grain, cereal, group 15
GC	0650	Rye	Rye	15	Grain, cereal, group 15
GC	0651	Sorghum	Sorghum, grain	15	Grain, cereal, group 15
GC	0447	Sweet corn	Corn, sweet	15	Grain, cereal, group 15
GC	0652	Teff or Tef	Teff	15	Grain, cereal, group 15
GC	0657	Teosinte	Teosinte	15	Grain, cereal, group 15
GC	0653	Triticale	Triticale	15	Grain, cereal, group 15
GC	0654	Wheat	Wheat	15	Grain, cereal, group 15
--	--	-	Wheatgrass, intermediate	15	Grain, cereal, group 15
GC	0655	Wild rice	Wild rice	15	Grain, cereal, group 15

SPECIFIC USES, PREPARATION FOR COOKING, AND MARKETING STANDARDS FOR PROPOSED MEMBERS OF THE CEREAL GRAIN CROP GROUP:

There are many uses of the cereal grain commodities and they are listed in Table 32. The preparation for cooking and nutrition of the cereal grains is listed in Table 33.

The number of foods prepared from a base of cereals is the largest of all food crops. Cereal grains are largely interchangeable for different uses and are, therefore, mutually competitive. They can substitute for one another in several food and nonfood uses. In their use as feeds they are almost completely interchangeable. That allows more latitude within which available grain supplies can satisfy a series of demands.

Table 32. Specific Uses and Availability in the Marketplace for Each Cereal Grain Commodity:

Commodity	Specific Uses and Availability in the Marketplace for the Cereal Grains
Amaranth, grain	In South America, seeds are often sold on the streets, popped like corn. Amaranth has no gluten, so it must be mixed with wheat to make leavened breads. It is popular in cereals, breads, muffins, crackers and pancakes; ground into flour or rolled into flakes. Forage and fodder are used as animal feed, as well as, grain and feed fractions. This grain is from Mexico and is similar in yield to rice or maize. It too is gluten-free and like quinoa, high in protein, iron, and fiber. Amaranth should be cooked 3 parts water to 1 part amaranth. To prepare, bring 3 cups of water to a boil in a pot with a tight-fitting lid. Add 1 cup of amaranth, cover the pot and lower the heat. Let it simmer until the water is absorbed, this should take about 20 minutes. Add grilled veggies, meat or tofu on a bed of

Commodity	Specific Uses and Availability in the Marketplace for the Cereal Grains
	amaranth for a dinner. For breakfast, have amaranth with fruit, nuts, butter and brown sugar. It's an easy way to get gluten-free grains in your diet.
Barley	About half of the barley grown in the United States is used for livestock feed. As feed it is nearly equal in nutritive value to kernel corn. It is especially valuable as hog feed, giving desirable portions of firm fat and lean meat. The entire kernel is used in feed, generally after grinding or steam rolling. Malt sprouts from malting as well as brewer's grain, by-products of brewing, are also valuable livestock feeds. Around 42% of the barley crop is used for malting in the United States. Of the malted barley, 80% is used for beer, around 14% for distilled alcohol products, and 6% for malt syrup, malted milk and breakfast foods. For malting, the barley is steeped in aerated water in large tanks for 45 - 65 hours, and then transferred to germinating tanks or compartments where it is held with intermittent stirring for 5 days at temperatures of 60-70 degrees F. During this treatment root sprouts emerge, but not the stems. This "green" malt is then dried in hot air kilns. For making beer the dried malt is crushed between rollers, mixed in proper proportions with slightly warm water, and held under rigidly controlled temperatures. The starch is converted by enzymatic reaction into maltose and dextrins. Proteins are also broken down by enzyme action. Upon completion of this process the solids settle out, the extract is filtered, then boiled with hops to add flavor, then cooled. Yeast is added to ferment the sugars into alcohol and carbon dioxide. The hop residue and proteins are then removed and the product (beer) is aged, chilled, filtered, pasteurized and bottled. Keg beer is similar but is not pasteurized or bottled. The solids from this process (brewer's grain) are a valuable livestock feed. Barley for human food is made into pearl barley by using abrasive disks to grind the hulls and bran off the kernels. After three successive "pearlings" or grinding operations all the hull and most of the bran is removed. At this stage the remaining kernel part is known as pot barley. Two or three additional pearlings produce pearl barley, in which most of the embryo is removed. These later pearlings also produce barley flour. Pot and pearl barley are used in soups and dressings. The flour is used in baby foods and breakfast cereals, or mixed with wheat flour in baking. Barley is also grown as a hay crop in some areas. Barley bran is a significant food in the U.S. and is used in cooking, cake, cookie and bread. Bran is obtained from milling of brewers spent grain and not the traditional dry milling of barely grain. Barley flakes (rolled barley) are used in hot cereal or as a thickening agent. Pearl barley (used in soups, or fed to live stock) is the decorticated caryopsis, while barley that can germinate and is then dehydrated is called malt. A very nourishing drink made from the latter can be used as a substitute for coffee. Barley is also used commercially in the making of beer and whiskey. For hay, only smooth-awned varieties or awnless are used. Winter barley also may be pastured moderately before the stems start to elongate. It furnishes nutritive pasturage, and grain yields are not seriously reduced. Availability in the marketplace: In the traditional areas, most barley is use for animal feed (half of the world's barley production). In the non-traditional areas, barley's principal use is as food, followed by animal feed and use as raw material for the malting industry. Pearl barley (used in soups, or fed to live stock) is the decorticated caryopsis, while barley that can germinate and is then dehydrated is called malt. A very nourishing drink made from the latter can be used as a substitute for coffee. Barley is also used commercially in the making of beer and whiskey. The cereal is prepared for eating by boiling or parching the whole grain. It can then be ground for gruel or made into flour for baking. Barley can also be grown as a hay crop.
Buckwheat	Most of the buckwheat grown in the United States is milled into flour which is used largely in pancakes. For pancakes the flour is usually blended with that from other grains. Approximately 100 lb of clean dry buckwheat seed yields 60 to 75 lb flour (52 lb pure white flour), 4 to 18 lb middlings and 18 to 26 lb hulls. Whole buckwheat grain may be used in poultry scratch feed mixtures. The middlings from milling make good livestock feed as they are high in protein. The straw is higher in protein but lower in digestible carbohydrates than grass grain straw. The buckwheat plant is an excellent honey source as the blossoms are rich in nectar, and blooming continues into the fall months. Some beekeepers plant buckwheat primarily for such use. Buckwheat is a short-season crop that is double-cropped following wheat, potato, sweet corn or peas in Washington. Green manure crop, extracted for pharmaceutical drug, rutin, soups, thickening agent, Kasha, and gravies. Once a major livestock feed, now its main uses are for human food. This gluten-free seed comes

Commodity	Specific Uses and Availability in the Marketplace for the Cereal Grains
	from a plant that is a cousin of greens such as rhubarb or sorrel. It is available as a flour or in its pure form. Buckwheat is high in magnesium, copper, and manganese, with a high fiber content that is said to lower blood sugar levels after meals. Buckwheat comes in groats, either raw or toasted, or as flour, as mentioned above.
Canarygrass, annual	Forage use is limited because of its low biomass production. It is grown as a food for caged and wild birds and often mixed with other grains, such as millet, safflower, sunflower seed, flaxseed and canola. Seed can also be used as a cereal or ground into flour for making cakes and puddings.
Cañihua	It is grown for its seed and used as a grain crop. The traditional and most frequent method of consumption is in the form of lightly roasted, ground grains which produce a flour called cañihuaco. This is consumed on its own, in cold or hot drinks, or in porridges. Over 15 different ways of preparing the whole grain and cañihuaco are known (as entrees, soups, stews, desserts and drinks). In the bakery industry, good results have been achieved by adding 20% of cañihuaco to wheat flour, which gives the product (bread, biscuits) a pleasant characteristic color and flavor. The dry stems and chaff produced when harvesting cañihua are a valued by-product for animal feeding. Gold/green dyes can be obtained from the whole plan. Pronounced kan-yee-wah, is sometimes confused with quinoa, because of mispronunciation, but this much smaller cousin of quinoa has an identity all its own. Its origin, use, and preparation are identical to quinoa; however, it doesn't have the saponin coating, making it a little easier to prepare. The preparation instructions for kaniwa are identical to that of quinoa. Kaniwa is crunchier and does not turn out fluffy like quinoa does. Add almond milk, nuts and berries for a breakfast that is nuttier in flavor than most. Like quinoa, it can also be added to salads, tossed with beans, tomatoes, and corn, or added to other grain dishes for texture. The dry stems and chaff produced when harvesting cañihua are a valued by-product for animal feeding. Gold/green dyes can be obtained from the whole plant.
Chia	Animal feed, thickening agent in soups, sauces, and diet foods, beverage base, oil seed, flour, health supplement. Coming from a plant in the mint family, chia seeds are high in fiber, calcium, phosphorus and omega-3 and omega-6 fatty acids. Chia seeds expand multiple times their size in water and help you feel fuller longer. They must be soaked in water beforehand to consume, after which time they take on a gel-like texture. Another way to incorporate them into your diet is by using ground chia seeds. Chia is generally seen in drinks, such as pre-workout shakes, bottled beverages and the like. Chia pudding, chia muffins and sprinkled on yogurt are some other ways to eat chia seeds.
Corn	Sweet corn is used as a vegetable for fresh market, canned and frozen. Corn grain is either dry or wet milled. Dry milling is primarily concerned with separation of the parts of the grain. Wet milling provides the same separation but further separates some of those parts into their chemical constituents, primarily starch, protein, oil, and fiber. Dry milling provides bran, germ, and endosperm. Corn grains, silage, stover, forage, aspirated grain fractions, cannery waste and milled byproducts are used for livestock feed. The popcorn seed is used for popping and direct consumption. Corn bran is also used commercially in breakfast cereals and comprise 5.3% of the kernel. Corn extracts are also fermented to produce an alcholic beer product in several countries. Blue corn has been traditionally used for Tortilla and Chips in New Mexico and Arizona. Corn for "Cornuts" was developed from the Cuzco Gigante race from Peru. Great economic significance worldwide as human food as animal feed, and as a source of large number of industrial products. It is mainly grown for food and livestock feed. The grain is ground to flour and used in starchy foods and breads. It is used in breakfast foods. Fermented grain is made into alcohol, which has become a prime use in the USA. A ton of dried corn would yield about 370 kg of ethanol. Corn starch is used in cosmetics, adhesives, glucose and syrup. Oil is extracted from the embryo and used as salad oil, and to make linolium, paints, varnishes. Though sometimes dismissed as a nutrient-poor starch and both a second-rate vegetable and a second-rate grain corn is lately being reassessed and viewed as a healthy food.
Cram-cram	Edible and nutritious, yet commonly considered a famine food. Grains are eaten raw, made into porridge, or mixed and cooked with other food. Can be made into bread or cakes. Valuable forage grass. Cattle like grazing it when it has just begun to sprout. The protein and fat contents are high compared to other cereals.
Fonio	Processing fonio is a difficult and time-consuming task because of the extremely small size of the

Commodity	Specific Uses and Availability in the Marketplace for the Cereal Grains
	grain. To make fonio more competitive on the market in terms of quality and price, it is necessary to improve grain processing techniques by modernizing existing and developing new equipment. Grain is made into porridge, ground and mixed with other cereals, or used in the brewing of beer. The straw can be used as fodder. The small grain contains about 80% carbohydrates and 10% protein. It contains amino acids like methionine and cystine which are essential to human health.
Huauzontle, grain	Leaves, flowers and seeds are edible and nutritious. Seeds can be used as a four or mixed with flour for preparing gruel and bread. Plant also used for gold and green colored dyes.
Job's tears	Seeds can be used decoratively, and stems for matting. Plant used medicinally as well. Fresh early vegetative growth in India showed 29.9% dry matter, 8.5% crude protein, 27.9% crude fiber, 8.96% ash, 2.7% ether extract and 51.9% nitrogen-free extract. The husked grain contains 10.8% moisture, 13.6% protein, 60% fat, 58.5% carbohydrate, 8.4% fiber and 2.6% ash.
Millet, finger	Cultivated as a cereal. Grains can be ground for porridge or made into a malt. Sprouted seeds can be eaten. Can be popped. Chemicals like hydrocyanic acid can be obtained
Millet, foxtail	It is cooked like rice, ground into flour, used to make alcoholic beverage, or fed to livestock. Green plants provide fodder. It is often used as a substitute for corn or sorghum.
Millet, pearl	It is cooked like rice, ground into flour, used to make alcoholic beverage, or fed to livestock. Good source of forage. It is often used as a substitute for maize or sorghum.
Millet, proso	The grain can be cooked and eaten as rice or ground for porridge or pudding. It is used for birdseed and can be grown as stover.
Oat	Oats are a nutritious feed for all classes of livestock. The hull, composed of lemma and palea, comprises on the average about 23% of the weight of the whole grain. Oats are high in mineral content and in several vitamins. Formerly largely fed to horses, oats are now used as feed for dairy cattle and poultry as well. Oat hulls from milling are used in poultry mash. For food use, the groat or inner kernel is rolled into flakes and used as oat meal in breakfast foods and baking. Oat flour contains an antioxidant which is used to preserve quality by delaying rancidity. Oat flour may also be mixed with wheat flour for multi-grain baked products. Oat products used for human foods include rolled oats, oat flakes, oat flour, oatmeal, oat bran, steel-cut oats (Scottish or Irish oats), and oat groats. Oat straw is more nutritious and palatable than wheat straw and is important as a supplementary feed on many farms. Fall sown oats furnish nutritious and palatable winter grazing in areas having mild winters. Oat grain is used for human consumption. Widely used in breakfast cereals.
Psyllium	Dietary fiber. Mucilage from the seed coat is used in ice cream and frozen desserts. The dehusked seed is milled off and is used in chicken and cattle feed.
Quinoa	Grain used in soup, ground flour for bread, roasted, made into an alcoholic beverage, pasta and cereal, also used as feed. In the U.S. sold as grain and cooked as rice. The leaves can be eaten as a vegetable like spinach. [HYPERLINK "https://www.thespruceeats.com/what-is-quinoa-3376836"]: Pronounced keen-wah, this high protein, the gluten-free seed is treated as a grain when it comes to cooking. It's the only "grain" that is a complete protein. It's high in iron, potassium, magnesium and fiber. You will easily find red or white(ivory) quinoa at your grocery store, although black is also easy to find.
Rice	Raw or parboiled milled rice is cooked and used as food. Many processed foods such as popped or puffed rice products are produced from brown rice or parboiled rice for use as breakfast cereals and snack foods. Beer, wine and spirits can be produced from the grain. Rice is mainly grown for food but it is also used in cosmetics, laundering starch, and textiles. An oil is produced and used as cooking and salad oil, for soap manufacture and it is made into a plastic packaging material. Husks are used as fuel, as an addition to concrete, for making hardboard and as an abrasive. Rice straw is the most common feed ingredient for cattle in many developing countries in Asia and Pacific region, particularly in Bangladesh, India, Myanmar, Nepal, Pakistan, Sri Lanka and Thailand. Urea-treated rice straw as cattle feed is popular in Bangladesh. Rice straw is for making and repairing thatched houses in Bangladesh, Nepal and India. It is used for construction of grain storage structures, ropes, packaging material and bags in India. It is also used as fuel in Vietnam. In China, India, Indonesia and Pakistan rice straw is used in the production of paper. In Myanmar rice husks are used as fuel for the operation of rice mills, for parboiling in Bangladesh, India, Myanmar Nepal and Sri Lanka, in China to produce steam or gas for power generation. Rice husks are also used as packaging and

Commodity	Specific Uses and Availability in the Marketplace for the Cereal Grains
	insulation material. Although rice husk exhibits a low protein and high fiber content, they are used as animal feed in Bangladesh, China and India. Crude bran oil is used in the production of soap. In China oryzanol is extracted from crude bran oil, which has pharmaceutical use. De-oiled rice bran is used to for the commercial extraction of phytin. Rice brokens have a variety of uses such as animal feed, making rice flour and malt sugar for breweries. It is used in a variety of ways to prepare processed rice based food products. The seed has nutrient, remineralizing, antidiarrhoeic and emollient properties and administration is as decoction and powder.
Rice, African	In West Africa, rice is grown as the main staple crop by 10 – 15 million people living in societies that are distributed along the coast, from the Casamance in Senegal to the bend of the Bandama River in the Ivory Coast. In addition, rice is an important but not a dominant crop in the drier savanna zones from the Senegal River to Lake Chad. Rice is also grown today as a commercial crop in Ghana and Nigeria. Presently, *O. glaberrima* is being replaced everywhere in West Africa by the Asian species.
Rice, Eastern	Cooked seed is edible. The seed is preserved for religious ceremonies. The root is medicinial
Rye	The grain is used for black bread, distilled alcohol, animal feed, pasture, hay, silage, and cover crop. Mature plant stalks are used in animal bedding, paper pulp, thatching and hats. It can be used as a hay crop if harvested early.
Sorghum, grain	Food, fuel, stover, and fiber. The grain can be ground into flour; some cultivars can be used as popcorn and the grain can be manufactured into beer. Stems are used for thatching, fencing, brushes, and basketry. A dye can be extracted. Grain and straw can be fed to livestock and embryos yield an oil used in cooking and salad oils. The inflorescence has astringent, haemostatic and antidiarrhoeic properties and administration is as infusion, tincture and medicinal wine. Nearly all (98%) of the sorghum grain consumed in the United States is used for livestock feed for cattle, swine and poultry. Of the 1994 supply about one-third was exported, mainly to Japan, India and Europe. Most of that exported was probably used as food. For food use, the grain may be roughly ground and made into bread like preparations, used after grinding and stewing as a mush or porridge, or made into flour for mixing with wheat flour for breads. Varieties with waxy endosperms are a source of starch having properties like tapioca. The grain is also a source of native beers, particularly in Africa. For feed use, sorghum grain should be ground for most classes of livestock, since the grains are small and relatively hard. In feeding value, it is almost equal to kernel corn. Some quantities of grain sorghums go into industrial uses in this country. Starch is manufactured by a wet-milling process like that used for corn starch. The starch is then made into dextrose for use in foods. Starch from waxy sorghums is used in adhesives and for sizing paper and fabrics, also in the "mud" used in drilling for oil. The grain is also a source of grain and butyl alcohol.
Teff	Grain can be ground into flour and used in breads, pancakes, soups and alcoholic beverages. Straw for animal feed. Can also be ornamental
Teosinte	Teosinte provides cover and long-term food supply for wildlife. Young growth can be used for forage. Birds will eat the seeds. Stalks can be used for silage
Triticale	Milling and baking; used in brewing, breakfast cereals and bread. Hay and forage.
Wheat	Wheat flour for bread, rolls, bagels, muffins, cracker,wheat germ, waffles, biscuits, cakes, macaroni, spaghetti, egg noodles, breakfast cereals
Wheatgrass, imtermediate	Milling for flour.
Wild rice	Edible grain cooked like rice, and used for flour, wildlife feed and shelter. It is used in soups, salads, and deserts. Folk remedies utilize it for a variety of ailments. Today some commercial cultivation takes place in California and the Midwest, but much of the crop is still harvested by Native Americans, largely in Minnesota.

Table 33. Preparation for Cooking and Nutrition of the Cereal Grains:

Crop	Preparation for Cooking and Nutrition
Amaranth, Grain	Amaranth has a high level of very complete protein; its protein contains lysine, an amino acid missing or negligible in many grains.
Barley	The fiber in barley is especially healthy and it may lower cholesterol even more effectively than oat fiber.
Buckwheat	The seed is ground into flour and provides stock and poultry feed, or it is roasted or boiled for food. Rutin is obtained from the leaves and flowers. The flowers are a source of honey. Used in cultural foods such as soba noodles, galettes, blinis, kasha, and pancakes.
Cañihua	Often the seed is roasted, ground and used as flour. It is consumed on its own, in cold or hot drinks, in porridges, entrees, soups, stews, desserts and in bakery mixed with wheat. The traditional and most frequent method of consumption is in the form of lightly roasted, ground grains which produce flour called cañihuaco. Over 15 different ways of preparing the whole grain and cañihuaco are known (as entrees, soups, stews, desserts and drinks. High protein content.
Chia	Composite flour (Chia with corn), ingredient for cookies, cereal, bars, chips, desserts, breads, jellies and emulsions, Chia seed oil, supplement. Seed produces essential fatty acids required by the human body that cannot be artificially synthesized.
Cram-cram	The grains are pounded and eaten raw, made into porridge, or mixed and cooked with other foods. The grain is also made into a drink. In Sudan, a thin bread ('kisra') is made from the grain and in Mauritania the ground grains are made into cakes. The grain is also a famine food in India, where it is eaten raw or used, mixed with pearl millet, to make bread. In normal years, it is mixed with sugar and 'ghee', and eaten as a children's food.
Huauzontle, grain	Before it can be consumed, biochemical toxins must be removed. The seeds are coated with saponins, chemicals with detergent-like properties that foam when water is added and that tend to damage animal cells when consumed. The commercial cultivars grown for foliage and used in salads, don't concentrate nitrates as quickly as wild types and are picked young and before they have had time to concentrate toxic levels in the leaves and the foliage is rich in calcium and vitamin A, comparable to spinach.
Job's tears	Can be ground into a flour and used to make bread or used in any of the ways that rice is used. The pounded flour is sometimes mixed with water like barley for barley water. The pounded kernel is also made into a sweet dish by frying and coating with sugar. It is also husked and eaten out of hand like a peanut.
Millet, finger	It is eaten by grinding the grains up for porridge or, as in Indonesia, eaten as a vegetable. Sometimes it is ground into flour and used for bread or various other baked products. The sprouted seeds are a nutritious and easily digested food that is recommended for infants and the elderly. The grain may be left to germinate to make malt, which is very popular in southern Africa due to the sweetness of the malt. Its ability to convert starch to sugar is surpassed only by barley. In Ethiopia, a powerful distilled liquor called arake is made from finger millet. In India finger millet is widely enjoyed as a popped grain. The protein content is low. The grass can be grown for green fodder or hay with a high nutritive value. Finger millet has variable nutritive value; protein contents ranging from 6 – 14% have been reported, fat 1.0 -1.4%, iron 5mg per 100g and food energy 323 - 350 KC. These are the more frequently given levels but in some samples, they are much higher. For the essential amino acids, the most noteworthy is methionine which is reported to be 3%, an exceptional figure for a cereal grain.
Millet, foxtail	It was used in India, China and Egypt before there was written records. Millet is

Crop	Preparation for Cooking and Nutrition
	still used in Eastern Europe for porridge and bread and for making alcoholic beverages. About 85% is used as food grain for humans and 6% for poultry. In the United States, it is grown chiefly for hay. The grain contains approximately 11.9% moisture, 9.7% protein, 1% fiber, 3.5% ether extract, 72.4% nitrogen-free extract and 1.5% ash.
Millet, little	It is cooked like rice, ground to flour, used to make an alcoholic beverage, or fed to livestock. It is often used as a substitute for maize or sorghum. The grain is highly nutritious, containing about 70% carbohydrate, and 10 - 18% protein.
Millet, pearl	The grain is cooked as rice, made into flour, or used to produce malt for beer. Whole grains are fed to poultry and livestock. The grain contains about 70% carbohydrate and 10% protein. .
Millet, proso	It is cooked like rice, ground into flour, used to make alcoholic beverage, or fed to livestock. It is cooked like rice, ground to flour, used to make an alcoholic beverage, or fed to livestock. Green plants provide hay. It is often used as a substitute for corn or sorghum. The grain is highly nutritious, containing about 70% carbohydrate, and 10 - 18% protein.
Oat	Almost never have their bran and germ removed in processing. In the U.S., most oats are steamed and flattened to produce "old-fashioned" or regular oats, quick oats, and instant oats. Scientific studies have concluded that like barley, oats contain a special kind of fiber called beta-glucan found to be especially effective in lowering cholesterol. Recent research reports indicate that oats also have a unique antioxidant, avenanthramides, that helps protect blood vessels from the damaging effects of LDL cholesterol.
Psyllium	The milled seed produces a white fibrous mucilage that can be used as a thickener in ice cream and frozen desserts. It is a dietary fiber. The dehusked seed that remains after the seed coat is milled off is rich in starch and fatty acids.
Quinoa	Most quinoa must be rinsed before cooking, to remove the bitter residue of saponins. The seeds are used in soups, made into an alcoholic beverage, or roasted and ground into flour. The plant can also be grown as a green vegetable, and its leaves can be eaten fresh or cooked. Leaves and seed can be fed to livestock. The abundant protein in quinoa is complete protein, which means that it contains all the essential amino acids our bodies can't make on their own. Quinoa is very easy to prepare. If you buy quinoa pre-washed, all you must do is cook it at two parts water to one part quinoa. or example, add one cup of dry quinoa to two cups of water in a saucepan, bring it to a boil, cover, then lower the heat so that it simmers for 10 - 15 minutes. It's like cooking rice. You can enjoy quinoa plain or add it to a salad, a soup, inside a pita wrap, with lentils or beans for dinner or enjoy it with breakfast with Greek yogurt, fresh fruit and a spice, such as an apple with cinnamon. Grain used in soup, ground flour for bread, roasted, made into an alcoholic beverage, pasta and cereal. Also, used as feed. In the U.S. sold as grain and cooked as rice. The leaves can be eaten as a vegetable like spinach.
Rice	The inedible hull must be removed. White rice is refined, with the germ and bran removed. Brown rice has much higher levels of many vitamins and minerals than white rice. Brown rice is an excellent source of manganese, just one cup of cooked brown rice provides 88% of your daily need.
Rye	The grain contains about 13% protein and 80% carbohydrates. Rye is unusual among grains for the high level of fiber in its endosperm and not just in its bran.
Sorghum, grain	Grain sorghum, which doesn't have an inedible hull like some other grains, is commonly eaten with all its outer layers, thereby retaining most its nutrients. Can be eaten like popcorn, cooked into porridge, ground into flour for baked goods, or even brewed into beer. Some specialty sorghums are high in antioxidants.
Teff	Usually ground into flour and fermented to make the spongy, sourdough bread known as injera. It can be cooked as porridge, added to baked goods, or even

Crop	Preparation for Cooking and Nutrition
	made into polenta. Teff has over twice the iron of other grains, and three times the calcium. It's estimated that 20 - 40% of the carbohydrates in teff are resistant starches.
Triticale	Scientists are testing triticale for possible use in breakfast cereals and for distilling or brewing, but so far, no exclusive commercial use has resulted. Triticale has 19.7% protein and 67.8% starch.
Wheat	Roller milling of wheat to obtain 70% extraction flour will generally reduce the levels of essential vitamins and minerals by 60 – 80%. The refined flour is mostly endosperm. Wheat is utilized mainly as flour (whole grain or refined) to produce a large variety of leavened and flat breads, and for the manufacture of a wide variety of other baking products such as biscuits, and confectionary. Fermented grains are made into various alcoholic drinks and industrial alcohol. Starch is used as cloth-stiffeners. Straws are fed to livestock, used for animal bedding and used in basketry and woven products. The most important source of dietary protein for humans. Though like other cereals, its protein is deficient in essential amino acids, especially lysine.
Wild rice	Processing wild rice for consumption causes little reduction in the nutritional value of the grain. Traditionally used by cooks as a stuffing for roasted gamebirds. Wild rice has twice the protein and fiber of brown rice, but less iron and calcium.

USDA MARKETING STANDARDS FOR CEREALS GRAINS

(USDA Agricultural Marketing Service, AMS, 2016.)

The USDA AMS (USDA AMS 1938, 1993, 1997, 2008, and 2016 has established standards for marketing many of the cereal grains and each will be discussed below. These marketing standards grades are an outgrowth of the widely accepted principle that price should be directly proportional to quality. One example for the cereal grains is the standard for barley (USDA Grain Inspection Service, June 1997 Subpart B United States Standards for Barley).

"§ 810.201 Definition of barley. Grain that, before the removal of dockage, consists of 50 % or more of whole kernels of cultivated barley (Hordeum vulgare L.) and not more than 25 % of other grains for which standards have been established under the United States Grain Standards Act. The term "barley" as used in these standards does not include hull-less barley or black barley. § 810.202 Classes of barley include the malting barley and barley types:

(1) **Malting barley**. Barley of a six-rowed or two-rowed malting type. The class Malting barley is divided into the following three subclasses:
(i) **Six-rowed Malting barley**. Barley that has a minimum of 95.0 %of a six-rowed suitable malting type that has 90 %t or more of kernels with white aleurone layers that contains not more than 1.9% injured-by-frost kernels, 0.4 % frost-damaged kernels, 0.2 percent injured-by-heat kernels, and 0.1 percent heat-damaged kernels. Six-rowed Malting barley shall not be infested, blighted, ergoty, garlicky, or smutty.
(ii) **Six-rowed Blue Malting barley**. Barley that has a minimum of 95 % of a six-rowed suitable malting type that has 90 % or more of kernels with blue aleurone layers that contains not more than 1.9 % injured-by-frost kernels, 0.4 % frostdamaged kernels, 0.2 % injured-by-heat kernels,

and 0.1 % heat-damaged kernels. Six-rowed Blue Malting barley shall not be infested, blighted, ergoty, garlicky, or smutty.
(iii) **Two-rowed Malting barley**. Barley that has a minimum of 95 % of a tworowed suitable malting type that contains not more than 1.9 % injured-by-frost kernels, 0.4 % frost-damaged kernels, 0.2 % injured-by-heat kernels, 0.1 % heat-damaged kernels, 1.9 % injured-by-mold kernels, and 0.4 % molddamaged kernels. Two-rowed Malting barley shall not be infested, blighted, ergoty, garlicky, or smutty.
(2) **Barley**. Any barley of a six-rowed or two-rowed type. The class Barley is divided into the following three subclasses:
(i) **Six-rowed barley**. Any six-rowed barley that contains not more than 10 % of two-rowed varieties.
(ii) **Two-rowed barley**. Any two-rowed barley with white hulls that contains not more than 10.0 5 of six-rowed varieties.

Damaged kernels. Kernels, pieces of barley kernels, other grains, and wild oats that are badly ground-damaged, badly weather-damaged, diseased, frost-damaged, germ damaged, heat-damaged, injured-by-heat, insect-bored, mold-damaged, sprout damaged, or otherwise materially damaged.
Dockage. All matter other than barley that can be removed from the original sample. Also, underdeveloped, shriveled, and small pieces of barley kernels removed in properly separating the material other than barley and that cannot be recovered by properly rescreening or recleaning. Foreign material. All matter other than barley, other grains, and wild oats that remains in the sample after removal of dockage. (g) Frost-damaged kernels. Kernels, pieces of barley kernels, other grains, and wild oats that are badly shrunken and distinctly discolored black or brown by frost. (h) Germ-damaged kernels. Kernels, pieces of barley kernels, other grains, and wild oats that have dead or discolored germ ends. (i) Heat-damaged kernels. Kernels, pieces of barley kernels, other grains, and wild oats that are materially discolored and damaged by heat. Injured-by-frost kernels. Kernels and pieces of barley kernels that are distinctly indented, immature, or shrunken in appearance or that are light green in color because of frost before maturity. Injured-by-mold kernels. Kernels and pieces of barley kernels containing slight evidence of mold. Other grains include: Black barley, corn, cultivated buckwheat, einkorn, emmer, flaxseed, guar, hull-less barley, nongrain sorghum, oats, Polish wheat, popcorn, poulard wheat, rice, rye, safflower, sorghum, soybeans, spelt, sunflower seed, sweet corn, triticale, and wheat.

CEREAL GRAIN COMMODITY DEFINITION DISCUSSION:

From the USDA IR-4 Proposal 5:

The original question is:

> "Does ChemSAC concur with the initial IR-4 proposal that one new commodity definitions [40 CFR § 180.1(g)] will be needed for this amended crop group for sugarcane which will cover sweet sorghum to harmonize with Codex (See Table below)? Also, IR-4 feels the current commodity definitions are adequate, and do not need changing."

Table 2. Proposed Codex Crop Group 021 Grasses for Sugar Production and Grasses and Other Plants for Syrup Production.

TABLE ON EXAMPLE OF SELECTION OF REPRESENTATIVE COMMODITIES
(GRASS COMMODITY GROUPS)
for inclusion in the Principles and Guidance for the Selection of Representative Commodities for the Extrapolation of Maximum Residue Limits for Pesticides for Commodity Groups (CAC/GL 84-2012)

Codex Group / Subgroup	**Examples of Representative Commodities**	**Extrapolation to the following commodities**
Group 021 Grasses for sugar production and grasses and other plants for syrup production	Sugar cane or Sweet Sorghum	Sorgo or Sorghum, Sweet; Sugar cane

HED ChemSAC Recommendations for Proposal 5:

We agree with USDA IR-4 that a separate Crop Group proposed by Codex for" Grasses for sugar production and grasses and other plants for syrup production. will not be useful since it has only one commodity. The only other grass besides sugarcane grown for syrup production is sweet sorghum. Sorgo is a lookup term for sweet sorghum.

However, because of the similarity in the RAC (cane or stalks) for syrup production will be adequately covered by a new commodity definition [40 CFR § 180.1(g)] will be adequate for sugarcane to cover sweet sorghum. Crushing the stems for extraction of the syrup are the same as for sugarcane syrup production. From 50 - 60 pounds of juice should be obtained from 100 pounds of cane, whereas 50 - 55 pounds of juice are obtained form 100 pounds of clean sweet sorghum stalks. The RAC for sugarcane is the cane and the RAC for sweet sorghum is the stalk or stover (OPPTS 860.1500). The processed commodity for sugarcane is blackstrap molasses which is like syrup or sirup for sweet sorghum.

Specific Commodities Included in Definition	Comments
A	B
Sugarcane	Sugarcane, Sweet sorghum

There are three commodity definitions [§ 180.1 (g)] relevant to Cereal Grain Crop Groups 15 and 16. No additional changes to these commodity definitions are recommended.:

Current commodity definitions:

Specific Commodities Included in Definition	Comments
A	B
Sorghum, grain, grain	*Sorghum* spp. (sorghum, grain, sudangrass (seed crop), and hybrids of these grown for its seed)
Sorghum, forage, stover	*Sorghum spp.* [sorghum, forage; sorghum, stover; sudangrass, and hybrids of these grown for forage and/or stover.
Wheat	Wheat, triticale

We agree with USDA IR-4 that these current commodity definitions will not need any changes.

CHANGES TO EPA DATABASES NEEDED FROM ESTABLISHMENT OF AN AMENDED CEREAL GRAIN CROP GROUP:

The establishment of an amended Legume Vegetable Crop Group will affect the need to update many Risk Assessment Models, Residue Chemistry Guidelines, OPP databases, and/or HED Standard Operating Procedures (SOP).

The affected EPA databases may include the following:

(1) Risk Assessment Models - The terminology in the Food Exposure Modules of our current Risk Assessment Models from DEEM-FCID, LIFELINE, and CARES will need to be updated to reflect new terminology and the new Crop Group terminology.

(2) EPA Residue Chemistry Test Guidelines (OPPTS 860.1000, Background), Table 1 Raw Agricultural and Processed Commodities and Feedstuffs Derived from Crops and EPA Residue Chemistry Test Guidelines (OPPTS 860.1000, Background), EPA Residue Chemistry Test Guidelines (OPPTS 860.1500, Crop Field Trials), Table 5 Suggested Distribution of Field Trials by Region for Crops Requiring > 3 trials and Table 6 Regional Distribution of Crop Production.

Any differences between the EPA and NAFTA Crop Production Regions after the NAFTA Regions are updated will be addressed by the ICCGR Workgroup or by the EPA HED ChemSAC with Canada, PMRA and Mexico. The EPA Residue Chemistry Test Guidelines (OPPTS 860.1500, Crop Field Trials) Table 5 Suggested Distribution of Field Trials by Region for Crops Requiring > 3 trials and Table 6 Regional Distribution of Crop Production will be updated to reflect more recent crop production information. There is currently no conflict with Canada.

(3) Health Effects Division Standard Operating Procedures: HED SOP 99.3 -[SEQ CHAPTER \h \r 1]– "Translation of Monitoring Data" issued March 26, 1999, updated 2016. This policy provides guidance on translating pesticide-monitoring data from one commodity to other similar commodities. Most of the monitoring data is from the USDA Pesticide Data Program (PDP) or the Food and Drug Administration (FDA). The policy is based on the crop groupings in the 40 CFR 180.41.

In the current SOP, there is entry for cereal grains for monitoring purposes.

(4) HED SOP 99.6 - [SEQ CHAPTER \h \r 1] "Classification of Food Forms with Respect to Level of Blending" issued August 20, 1999, updated 2017. This SOP provides rationale and guidance to HED on revised criteria for inputting residue values and pesticide usage information into acute dietary exposure and risk assessments based on commodities. These revisions permit the Agency to fully utilize data generated by the USDA Pesticide Data Program.

Some of the members of the Cereal Grain Crop Group 15 are in the HED SOP 99.6. See Table 34 below. The members of the amended Cereal Grain crop group are considered either blended (B) or partially blended (PB) commodities. For example, dry beans are blended while green beans succulent are all partially blended (PB) commodities. They are all mostly cooked and boiled.

Table 34. Classification of Food Forms with Respect to Level of Blending for the Cereal Grain Crop Group 15. (HED SOP 99.6, April 20, 1999, updated 2017).

COMMODITY	**FOOD FORM**	**CLASSIFICATION: (B – Blended; NB – Not blended; PB – Partially blended)**
Barley	11-Uncooked	B
Barley	12- Cooked: NFS	B
Barley	13-Baked	B
Barley	14-Boiled	B
Barley	15-Fried	B
Barley	31-Canned: NFS	B
Barley	32- Canned: Cookedd	B
Barley	34- Canned: Boiled	B
Barley	99- Alcohol/Fermented/Distilled	B
Corn grain/sugar/hfcs	98- Refined	B
Corn grain/sugar-molasses	12- Cooked: NFS	B
Corn grain/sugar-molasses	41- Frozen: NFS	B
Corn grain - bran	12- Cooked: NFS	B
Corn grain - bran	13- Baked	B

COMMODITY	FOOD FORM	CLASSIFICATION: (B – Blended; NB – Not blended; PB – Partially blended)
Corn grain - bran	14 - Boiled	B
Corn grain - bran	15 - Fried	B
Corn grain - bran	31 – Canned: NFS	B
Corn grain-endosperm	11-Uncooked	B
Corn grain-endosperm	12- Cooked: NFS	B
Corn grain-endosperm	13- Baked	B
Corn grain-endosperm	14 - Boiled	B
Corn grain-endosperm	15 - Fried	B
Corn grain-endosperm	31 – Canned: NFS	B
Corn grain-endosperm	32 – Canned: Cooked	B
Corn grain-endosperm	33- Canned: Baked	B
Corn grain-endosperm	34- Canned: Boiled	B
Corn grain-endosperm	41- Frozen: NFS	B
Corn grain-endosperm	42- Frozen: Cooked	B
Corn grain-endosperm	43– Frozen: Baked	B
Corn grain-endosperm	45- Frozen: Fried	B
Corn grain-endosperm	99- Alcohol/Fermented/Distilled	B
Corn grain-oil	98 - Refined	B
Corn/pop	12- Cooked: NFS	B
Corn/pop	13- Baked	B
Corn/sweet	11-Uncooked	NB
Corn/sweet	12- Cooked: NFS	NB
Corn/sweet	13- Baked	NB
Corn/sweet	14 - Boiled	NB
Corn/sweet	32 – Canned: Cooked	PB
Corn/sweet	34- Canned: Boiled	PB
Corn/sweet	35- Canned: Fried	PB
Corn/sweet	42- Frozen: Cooked	PB
Millet	13- Baked	B
Oats	11-Uncooked	B
Oats	12- Cooked: NFS	B
Oats	13- Baked	B
Oats	14 - Boiled	B
Oats	15 - Fried	B
Oats	31 – Canned: NFS	B
Oats-bran	11-Uncooked	B
Oats-bran	12- Cooked: NFS	B
Oats-bran	13- Baked	B
Oats-bran	14 - Boiled	B
Oats-bran	15 - Fried	B

COMMODITY	FOOD FORM	CLASSIFICATION: (B – Blended; NB – Not blended; PB – Partially blended)
Rice-bran	11-Uncooked	B
Rice-bran	12- Cooked: NFS	B
Rice-bran	13- Baked	B
Rice-bran	15 - Fried	B
Rice-bran	31 – Canned: NFS	B
Rice-milled (white)	12- Cooked: NFS	B
Rice-milled (white)	13- Baked	B
Rice-milled (white)	14 - Boiled	B
Rice-milled (white)	15 - Fried	B
Rice-milled (white)	31 – Canned: NFS	B
Rice-milled (white)	32 – Canned: Cooked	B
Rice-milled (white)	42- Frozen: Cooked	B
Rice-milled (white)	99- Alcohol/Fermented/Distilled	B
Rice-rough (brown)	12- Cooked: NFS	B
Rice-rough (brown)	13- Baked	B
Rice-rough (brown)	14 - Boiled	B
Rice-rough (brown)	99- Alcohol/Fermented/Distilled	B
Rice-wild	14 - Boiled	B
Rice-wild	42- Frozen: Cooked	B
Rye-flour	13- Baked	B
Rye-germ	13- Baked	B
Rye-rough	12- Cooked: NFS	B
Rye-rough	13- Baked	B
Wheat-bran	11-Uncooked	B
Wheat-bran	12- Cooked: NFS	B
Wheat-bran	13- Baked	B
Wheat-flour	11-Uncooked	B
Wheat-flour	12- Cooked: NFS	B
Wheat-flour	13- Baked	B
Wheat-flour	14 - Boiled	B
Wheat-flour	15 - Fried	B
Wheat-flour	31 – Canned: NFS	B
Wheat-flour	32 – Canned: Cooked	B
Wheat-flour	33- Canned: Baked	B
Wheat-flour	34- Canned: Boiled	B
Wheat-flour	41- Frozen: NFS	B
Wheat-flour	42- Frozen: Cooked	B
Wheat-flour	43– Frozen: Baked	B
Wheat-flour	45- Frozen: Fried	B
Wheat-flour	52- Cured: Cooked	B

COMMODITY	FOOD FORM	CLASSIFICATION: (B – Blended; NB – Not blended; PB – Partially blended)
	(smoked/pickled)	
Wheat-germ	12- Cooked: NFS	B
Wheat-germ	13- Baked	B
Wheat-germ	14 - Boiled	B
Wheat-germ oil	13- Baked	B
Wheat-rough	11-Uncooked	B
Wheat-rough	12- Cooked: NFS	B
Wheat-rough	13- Baked	B
Wheat-rough	14 - Boiled	B

(5) HED SOP 2000.1 – "[SEQ CHAPTER \h \r 1]Guidance for Translation of Field Trial Data from Representative Commodities in the Crop Group Regulation to Other Commodities in Each Crop Group/Subgroup" issued September 12, 2000, updated July 31, 2018.

There is guidance in the SOP for the Cereal grain crop group 15.

Amended Crop Group 15-19: Ceral Grain Crop Group.

The proposed translations of field trials from the representative commodities to other commodities in the Cereal grain crop group 15 are as follows:

Crop Group 15: Cereal grains

Representative commodities: Wheat, Barley, Field corn, Sweet corn, Grain sorghum or proso millet, and Rice

COMMODITY	REPRESENTATIVE COMMODITY
Amaranth, grain	Wheat
Amaranth, purple	Wheat
Baby corn	Corn, sweet
Barley	Barley
Buckwheat	Barley
Buckwheat, Tartary	Barley
Canarygrass, annual	Barley
Cañihua	Wheat
Chia	Wheat
Corn, field	Corn, field
Corn, sweet	Corn, sweet

COMMODITY	REPRESENTATIVE COMMODITY
Cram-cram	Wheat
Fonio, black	Grain sorghum or proso millet
Fonio, black	Grain sorghum or proso millet
Huauzonte, grain	Wheat
Inca wheat	Wheat
Job's tears	Grain sorghum or proso millet
Millet, barnyard	Grain sorghum or proso millet
Millet, finger	Grain sorghum or proso millet
Millet, foxtail	Grain sorghum or proso millet
Millet, little	Grain sorghum or proso millet
Millet, pearl	Grain sorghum or proso millet
Millet, proso	Grain sorghum or proso millet
Oat	Barley
Oat, Abyssinian	Barley
Oat, common	Barley
Oat, naked	Barley
Oat, sand	Barley
Popcorn	Corn, field
Princess-feather	Wheat
Psyllium	Wheat
Psylliun, blond	Wheat
Quinoa	Wheat
Rice	Rice
Rice, African	Rice
Rye	Wheat
Sorghum, grain	Sorghum, grain
Teff	Grain sorghum or proso millet
Teosinte	Corn, field
Triticale	Wheat
Wheat	Wheat
Wheat, club	Wheat
Wheat, common	Wheat
Wheat, durum	Wheat
Wheat, Einkorn	Wheat
Wheat, Emmer	Wheat
Wheat, macha	Wheat
Wheat, oriental	Wheat

COMMODITY	REPRESENTATIVE COMMODITY
Wheat, Persian	Wheat
Wheat, Polish	Wheat
Wheat, Poulard	Wheat
Wheat, shot	Wheat
Wheat, spelt	Wheat
Wheat, Timopheevi	Wheat
Wheat, Vavilovi	Wheat
Wheat, wild einkorn	Wheat
Wheat, wild emmer	Wheat
Wheatgrass, intermediate	Wheat
Wild rice	Rice
Wild rice, Eastern	Rice

The proposed translations of field trials from the representative commodities to other commodities in the Cereal Grain subgroups are as follows:

Crop Subgroup 15A - 19: Wheat subgroup
Representative commodities: Wheat

COMMODITY	REPRESENTATIVE COMMODITY
Amaranth, grain	Wheat
Amaranth, purple	Wheat
Cañihua	Wheat
Chia	Wheat
Cram-cram	Wheat
Huauzonte, grain	Wheat
Inca wheat	Wheat
Princess-feather	Wheat
Psyllium	Wheat
Psylliun, blond	Wheat
Quinoa	Wheat
Rye	Wheat
Triticale	Wheat
Wheat	Wheat
Wheat, club	Wheat
Wheat, common	Wheat
Wheat, durum	Wheat

COMMODITY	REPRESENTATIVE COMMODITY
Wheat, Einkorn	Wheat
Wheat, Emmer	Wheat
Wheat, macha	Wheat
Wheat, oriental	Wheat
Wheat, Persian	Wheat
Wheat, Polish	Wheat
Wheat, Poulard	Wheat
Wheat, shot	Wheat
Wheat, spelt	Wheat
Wheat, Timopheevi	Wheat
Wheat, Vavilov	Wheat
Wheat, wild einkorn	Wheat
Wheat, wild emmer	Wheat
Wheatgrass, intermediate	Wheat

Crop Subgroup 15B - 19: Barley subgroup
Representative commodities: Barley

COMMODITY	REPRESENTATIVE COMMODITY
Barley	Barley
Buckwheat	Barley
Buckwheat, Tartary	Barley
Canarygrass, annual	Barley
Oat	Barley
Oat, Abyssinian	Barley
Oat, common	Barley
Oat, naked	Barley
Oat, sand	Barley

Crop Subgroup 15C - 19: Corn subgroup
Representative commodities: Field corn and sweet corn

COMMODITY	REPRESENTATIVE COMMODITY
Baby corn	Corn, sweet
Corn, field	Corn, field
Corn, sweet	Corn, sweet
Popcorn	Corn, field

COMMODITY	REPRESENTATIVE COMMODITY
Teosinte	Corn, field

Crop Subgroup 15D - 19: Grain sorghum or millet subgroup
Representative commodities: Grain sorghum or Proso millet

COMMODITY	REPRESENTATIVE COMMODITY
Fonio, black	Grain sorghum or proso millet
Fonio, black	Grain sorghum or proso millet
Job's tears	Grain sorghum or proso millet
Millet, barnyard	Grain sorghum or proso millet
Millet, finger	Grain sorghum or proso millet
Millet, foxtail	Grain sorghum or proso millet
Millet, little	Grain sorghum or proso millet
Millet, pearl	Grain sorghum or proso millet
Millet, proso	Grain sorghum or proso millet
Sorghum, grain	Sorghum, grain
Teff	Grain sorghum or proso millet

Crop Subgroup 15E - 19: Rice subgroup
Representative commodities: Rice

COMMODITY	REPRESENTATIVE COMMODITY
Rice	Rice
Rice, African	Rice
Wild rice	Rice
Wild rice, Eastern	Rice

The proposed translations of field trials from the representative commodities to other commodities in the Forage, fodder and straw of cereal grains crop group 16 are as follows:

Crop Group 16-19: Forage, hay, stover, and straw of cereal grains
Representative commodities: Corn; Wheat; and any other cereal grain crop

COMMODITIES
The commodities in this crop group consist of: the forage, stover, and straw of all commodities included in the Cereal grains crop group.

(6) HED Dry Matter Database will be updated to add the Table below:

Table 35. Health Effects Division Dry Matter Database. Cereal Grain Crop Group 15.
Prepared by Dr's. NG and B. A. Schneider. June 6, 2017, [HYPERLINK "http://ndb.nal.usda.gov/ndb/foods"].
Siddiq, M and M. Uebersax., 2013.

Commodity	% Dry Matter
Amaranth, grain	90.2
Barley, bran	90.0
Barley, flour	88.8.
Barley, grain	88.0
Barley, malt sorouts, dehydrated	93.0
Barley, pearled barley	90.0
Corn, field, bran	89.0, 95.2
Corn, field, flour	89.1
Corn, field, grain	88.0, 90.0
Corn, field, grits	88.0 90.0
Corn, field, meal	89.7, 89.8
Corn, field, milled byproducts	85.0
Corn, field, molasses	73.0
Corn, field, refined oil	99.0
Corn, field, syrup	75.0
Corn, pop, grain	88.0, 90.0
Corn, sweet, cannery waste	30.0
Corn, sweet, grain	91.0
Millet, flour	89.0
Millet, grain	88.0
Millet, pearl, grain	88.0
Millet, proso, grain	90.0
Oat, bran	93.5
Oat, flour	88.0, 89.0
Oat, grain	89.0
Oat, groats/rolled oats	91.0
Quinoa, grain	90.7, 91.0
Rice, bran	90.0, 91.0
Rice, brown	88.0
Rice, grain	88.0
Rice, polished rice	89.0, 90.0
Rye, bran	91.0
Rice, disterellers, grain, dehydrated	92.0
Rye, flour	88.0, 90.0, 91.0
Rye, grain	88.0, 91.0
Sorghum, grain, flour	88.0
Sorghum, grain, grain	86.0, 89.0

Commodity	% Dry Matter
Sorghum, sweet, syrup	77.0
Triticale, flour	87.0, 90.0
Wheat, bran	89.0, 90.0, 90.1
Wheat, germ	85.0, 88.9
Wheat, gluten	90.0
Wheat, grain	89.0
Wheat, middlings	89.0
Wheat, milled byproducts	88.0
Wheat, shorts	88.0
Wheat, straw	88.0

Table 36. Health Effects Division Dry Matter Database. Forage, Fodder and Straw of the Cereal Grain Group 16. Prepared by Dr's. NG and B. A. Schneider. June 6, 2017, [HYPERLINK "http://ndb.nal.usda.gov/ndb/foods"]. Siddiq, M and M. Uebersax., 2013.

Commodity	% Dry Matter
Aspirated grain fractions	85.0
Barley, hay	88.0
Barley, straw	89.0, 91.0
Corn, field, forage	40.0
Corn, field, silage	22.0, 22.6
Corn, pop, stover	85.0
Corn, sweet, forage	48.0
Corn sweet, kernel plus cob with husks removed	24.7
Corn, sweet, stover	83.0, 88.0
Millet, forage	25.0
Millet, hay	85.0
Millet, Japanese, hay	87.0
Millet, straw	90.0
Oat, hay	90.0
Oat, silage	35.0
Oat, straw	90.0, 90.1
Rice, hulls	90.0, 92.0
Rice, straw	90.0, 91.0
Rye, forage	30.0
Rye, hay	93.0
Rye, straw	88.0
Sorghun, grain, foeage	35.0
Sorghum, grain, stover	88.0
Wheat, forage	22.0, 25.0
Wheat, hay	88.0
Wheat, straw	88.0

TOLERANCE EXPRESSION GUIDANCE:

Until the Federal Register Notice is issued revising the Crop Group Regulation to establish an amended crop group15 for the Cereal Grains the commodities approved for the crop group should be listed as separate commodities at the same tolerance level as the representative commodity for the group. When ChemSAC approves the Cereal Grain Crop Group 15-19, the Minor Use and Emergency Response Branch (MUERB), Registration Division of the Registration Division can immediately implement the amended Crop Group with new tolerance expressions located in the Section F submissions. The following tolerance expression examples will provide an expedited way to establish tolerances in or on Cereal Grain crops, especially for new reduced risk pesticides, without requiring additional residue data for all the crops noted. This will create a practice in the United States, which is already formalized in Canada, and promote international harmonization. Several tolerance expression examples for guidance purposes for use by RD and HED reviewers will be listed below:

Example 1. What is the tolerance expression for the amended Cereal Grain crop group 15-19?

Answer to Example 1:

The tolerance expression will be amended Grain, cereal, group 15-19."

Example 2. How will the Crop group and subgroups appear in the Federal Register for the proposed crop group regulation [40CFR 180.41(c)]? This example is for the Field and External Affairs Division (FEAD) and Registration Division (RD) use in preparing the new Federal Register Regulation. The example follows the same format as the current Crop Grouping Regulation Federal Register Notice (FR 60, No.95, 5/17/95, 26626-26643.

Answer to Example 2:

The list of acceptable Cereal Grain crops and their scientific names for the ?60 commodities were also updated and are listed below.

Answer to Example 2:

§ 180.41 Crop group tables.

*   *   *   *   *

(c)   *   *   *

(?) *Crop Group 15*-19: Cereal Grain Group.

(i) *Representative commodities.* Wheat, barley, field corn, sweet corn, grain sorghum or millet, and rice.

(ii) *Commodities*. The following Table 1 is a list of all commodities included in Crop Group 15-19 and includes cultivars, varieties and/or hybrids of these commodities.

Table 1. Crop Group 15-19: Cereal Grain Group

Table. The following Table 1 lists all the commodities listed in Crop Group 15-19 and identifies the related crop subgroups and includes cultivars, varieties and/or hybrids of these commodities.

Commodities	**Related crop subgroups**
Amaranth, grain, *Amaranthus* spp.	15A
Amaranth, purple, *Amaranthus cruentus* L.	15A
Baby corn, *Zea mays* L. subsp. *mays*	15C
Barley, *Hordeum vulgare* L. subsp. *vulgare*	15B
Buckwheat, *Fagopyrum esculentum* Moench	15B
Buckwheat, Tartary, *Fagopyrum tataricum* (L.) Gaertn.	15B
Canarygrass, Annual, *Phalaris canariensis* L.	15B
Cañihua, *Chenopodium pallidicaule* Aellen	15A
Chia, *Salvia hispanica* L.	15A
Corn, field, *Zea mays* L. subsp. *mays*	15C
Corn, sweet, *Zea mays* L. subsp. *mays*	15C
Cram-cram, *Cenchrus biflorus* Roxb.	15A
Fonio, black, *Digitaria iburua* Stapf	15D
Fonio, white, *Digitaria exilis* (Kippist) Stapf	15D
Huauzontle, grain, *Chenopodium berlandieri* Moq. subsp. *nuttalliae* (Saff.) H. D. Wilson & Heiser and *Chenopodium berlandier* Moq.	15A
Inca wheat, *Amaranthus caudatus* L.	15A
Job's tears, *Coix lacryma-jobi* L., *Coix lacryma-jobi* L. var. ma-yun (Rom. Caill.) Stapf	15D
Millet, barnyard, *Echinochloa frumentacea* Link.	15D
Millet, finger, *Eleusine coracana* (L.) Gaertn. subsp. *coracana*	15D
Millet, foxtail, *Setaria italica* (L.) P. Beauv. subsp. *italic*	15D
Millet, little, *Panicum sumatrense* Roth	15D
Millet, pearl, *Pennisetum glaucum* (L.) R. B. r	15D
Millet, proso, *Panicum miliaceum* L. subsp. *miliaceum*	15D
Oat, *Avena spp.*	15B
Oat, Abyssinian, *Avena abyssinica* Hochst. ex A. Rich.	15B
Oat, common, *Avena sativa* L.	15B
Oat, naked, *Avena nuda* L.	15B
Oat, sand, *Avena strigosa* Schreb.	15B
Popcorn, *Zea mays* L. subsp. *mays*	15C
Princess-feather, *Amaranthus hypochondriacus* L.	15A
Psyllium, *Plantago arenaria* Waldst. & Kit.	15A
Psyllium, blond, *Plantago ovata* Forssk.	15A
Quinoa, *Chenopodium quinoa* Willd. subsp. *quinoa*	15A
Rice, *Oryza sativa* L.	15E
Rice, African, *Oryza glaberrima* Steud.	15E
Rye, *Secale cereale* L. subsp. *cereal*	15A

Commodities	**Related crop subgroups**
Sorghum, grain, *Sorghum bicolor* (L.) Moench	15D
Teff, *Eragrostis tef* (Zuccagni) Trotter	15D
Teosinte, *Zea mays* L. subsp. *mexicana* (Schrad.) H. H. Iltis.	15C
Triticale, X *Triticosecale* spp.	15A
Wheat, *Triticum* spp.	15A
Wheat, club, *Triticum aestivum* L. subsp. *compactum* (Host) Mackey	15A
Wheat, common, *Triticum aestivum* L. subsp. *aestivum*	15A
Wheat, durum, *Triticum turgidum* L. subsp. *durum* (Desf.) van Slageren	15A
Wheat, Einkorn, *Triticum monococcum* L. subsp. *monococcum*	15A
Wheat, Emmer, *Triticum turgidum* L. subsp. *dicoccon* (Schrank) Thell.	15A
Wheat, macha, *Triticum aestivum* L. subsp. *macha* (Dekapr. & Menabde) Mackey	15A
Wheat, oriental, *Triticum turgidum* L. subsp. *turanicum* (Jakubz.) Á. Löve & D. Löve	15A
Wheat, Persian, *Triticum turgidum* L. subsp. *carthlicum* (Nevski) Á. Löve & D. Löve	15A
Wheat, Polish, *Triticum turgidum* L. subsp. *polonicum* (L.) Thell.	15A
Wheat, Poulard, *Triticum turgidum* L. subsp. *turgidum*	15A
Wheat, shot, *Triticum aestivum* L. subsp. *sphaerococcum* (Percival) Mackey	15A
Wheat, spelt, *Triticum aestivum* L. subsp. *spelta* (L.) Thell.	15A
Wheat, Timopheevi, *Triticum timopheevii* (Zhuk.) Zhuk. subsp. *timopheevii*	15A
Wheat, Vavilovi, *Triticum vavilovii* Jakubz.	15A
Wheat, Wild einkorn, *Triticum monococcum* L. subsp. *aegilopoides* (Link) Thell.	15A
Wheat, Wild emmer, *Triticum turgidum* L. subsp. *dicoccoides* (Körn. ex Asch. & Graebn.) Thell.	15A
Wheatgrass, intermediate, *Iseilema prostratum* (L.) Andersson	15A
Wild rice, *Zizania palustris* L.	15E
Wild rice, Eastern, *Zizania aquatica* L.	15E
Cultivars, varieties, and hybrids of these commodities.	

Table. The following Table 2 identifies the crop subgroups for Crop Group 15-19, specifies the representative commodities for each subgroup and lists all the commodities included in each subgroup.

Table 2. Crop Group 15-19: Subgroup Listing

Representative commodities	**Commodities**
Crop Subgroup 15-19A: Wheat subgroup.	
Wheat.	Amaranth, Grain; Amaranth, Purple; Cañihua; Chia; Cram-cram; Huauzontle, grain; Inca wheat; Princess-feather; Psyllium; Psyllium, blond; Quinoa; Rye; Triticale; Wheat; Wheat, Club; Wheat, Common; Wheat, Durum; Wheat, Einkorn; Wheat, Emmer; Wheat, Macha; Wheat, Oriental; Wheat, Persian; Wheat, Polish; Wheat, Poulard; Wheat, Shot; Wheat, Spelt; Wheat, Timopheevi; Wheat, Vavilovi; Wheat, Wild einkorn; Wheat, Wild emmer; Wheatgrass, intermediate; cultivars, varieties, and hybrids of these commodities. cultivars, varieties, and hybrids of these commodities.
Crop Subgroup 15-19B: Barley subgroup	
Barley.	Barley; Buckwheat; Buckwheat, Tartary; Oat: Oat, Abyssinian; Oat, Common; Oat, Naked; Oat, Sand; cultivars, varieties, and hybrids of these commodities.
Crop Subgroup 15-19C: Corn subgroup	
Field corn and sweet corn	Baby corn; Corn, field; Corn, sweet; Popcorn; Teosinte; cultivars, varieties, and hybrids of these commodities.
Crop Subgroup 15-19D: Grain sorghum or millet subgroup	
Grain sorghum or Proso millet	Fonio, black; Fonio, white; Job's tears; Millet, Barnyard; Millet, Finger; Millet, Foxtail; Millet, Little; Millet, Pearl; Millet, Proso; Sorghum, Grain; Teff; cultivars, varieties, and hybrids of these commodities.
Crop Subgroup 15-19E: Rice subgroup	
Rice.	Rice; Rice, African; Wild rice; Wild rice, Eastern; cultivars, varieties, and hybrids of these commodities.

Example 3. What is the tolerance expression for the amended Forage, hay, stover, and straw of the cereal grain crop group 16-19?

Answer to Example 3:

The tolerance expression will be amended Forage, hay, stover, and straw of the cereal grain group 16-19."

Example 4. How will the Crop group appear in the Federal Register for the proposed crop group regulation [40CFR 180.41(c)]? This example is for the Field and External Affairs Division (FEAD) and Registration Division (RD) use in preparing the new Federal Register Regulation. The example follows the same format as the current Crop Grouping Regulation Federal Register Notice (FR 60, No.95, 5/17/95, 26626-26643.

Answer to Example 4:

The list of acceptable Forage, hay, stover, and straw of cereal grain group 16-19 and their scientific names for the 60 commodities were also updated and are listed below.

§ 180.41 Crop group tables.

* * * * *

(c) * * *

(?) Crop Group 16-19: Forage, Hay, Stover, and Straw of Cereal Grain Group.

(i) *Representative commodities.* Corn, wheat, and any other cereal grain crop.

(ii) *Commodities*. The following Table 1 is a list of all commodities included in Crop Group 16-19 and includes cultivars, varieties and/or hybrids of these commodities.

Table 1. Crop Group 16-19: Forage, Hay, Stover and Straw of Cereal Grain Group

Table. The following Table 1 lists all the commodities listed in Crop Group 15-19, and includes cultivars, varieties and/or hybrids of these commodities.

Commodities
Amaranth, grain, *Amaranthus* spp.
Amaranth, purple, *Amaranthus cruentus* L.
Baby corn, *Zea mays* L. subsp. *mays*
Barley, *Hordeum vulgare* L. subsp. *vulgare*
Buckwheat, *Fagopyrum esculentum* Moench
Buckwheat, Tartary, *Fagopyrum tataricum* (L.) Gaertn.
Canarygrass, Annual, *Phalaris canariensis* L.
Cañihua, *Chenopodium pallidicaule* Aellen
Chia, *Salvia hispanica* L.

Commodities
Corn, field, *Zea mays* L. subsp. *mays*
Corn, sweet, *Zea mays* L. subsp. *mays*
Cram-cram, *Cenchrus biflorus* Roxb.
Fonio, black, *Digitaria iburua* Stapf
Fonio, white, *Digitaria exilis* (Kippist) Stapf
Huauzontle, grain, *Chenopodium berlandieri* Moq. subsp. *nuttalliae* (Saff.) H. D. Wilson & Heiser and *Chenopodium berlandier* Moq.
Inca wheat, *Amaranthus caudatus* L.
Job's tears, *Coix lacryma-jobi* L., *Coix lacryma-jobi* L. var. ma-yun (Rom. Caill.) Stapf
Millet, barnyard, *Echinochloa frumentacea* Link.
Millet, finger, *Eleusine coracana* (L.) Gaertn. subsp. *coracana*
Millet, foxtail, *Setaria italica* (L.) P. Beauv. subsp. *italic*
Millet, little, *Panicum sumatrense* Roth
Millet, pearl, *Pennisetum glaucum* (L.) R. B. r
Millet, proso, *Panicum miliaceum* L. subsp. *miliaceum*
Oat, *Avena spp.*
Oat, Abyssinian, *Avena abyssinica* Hochst. ex A. Rich.
Oat, common, *Avena sativa* L.
Oat, naked, *Avena nuda* L.
Oat, sand, *Avena strigosa* Schreb.
Popcorn, *Zea mays* L. subsp. *mays*
Princess-feather, *Amaranthus hypochondriacus* L.
Psyllium, *Plantago arenaria* Waldst. & Kit.
Psyllium, blond, *Plantago ovata* Forssk.
Quinoa, *Chenopodium quinoa* Willd. subsp. *quinoa*
Rice, *Oryza sativa* L.
Rice, African, *Oryza glaberrima* Steud.
Rye, *Secale cereale* L. subsp. *cereal*
Sorghum, grain, *Sorghum bicolor* (L.) Moench
Teff, *Eragrostis tef* (Zuccagni) Trotter
Teosinte, *Zea mays* L. subsp. *mexicana* (Schrad.) H. H. Iltis.
Triticale, X *Triticosecale* spp.
Wheat, *Triticum* spp.
Wheat, club, *Triticum aestivum* L. subsp. *compactum* (Host) Mackey
Wheat, common, *Triticum aestivum* L. subsp. *aestivum*
Wheat, durum, *Triticum turgidum* L. subsp. *durum* (Desf.) van Slageren
Wheat, Einkorn, *Triticum monococcum* L. subsp. *monococcum*
Wheat, Emmer, *Triticum turgidum* L. subsp. *dicoccon* (Schrank) Thell.
Wheat, macha, *Triticum aestivum* L. subsp. *macha* (Dekapr. & Menabde) Mackey
Wheat, oriental, *Triticum turgidum* L. subsp. *turanicum* (Jakubz.) Á. Löve & D. Löve

Commodities
Wheat, Persian, *Triticum turgidum* L. subsp. *carthlicum* (Nevski) Á. Löve & D. Löve
Wheat, Polish, *Triticum turgidum* L. subsp. *polonicum* (L.) Thell.
Wheat, Poulard, *Triticum turgidum* L. subsp. *turgidum*
Wheat, shot, *Triticum aestivum* L. subsp. *sphaerococcum* (Percival) Mackey
Wheat, spelt, *Triticum aestivum* L. subsp. *spelta* (L.) Thell.
Wheat, Timopheevi, *Triticum timopheevii* (Zhuk.) Zhuk. subsp. *timopheevii*
Wheat, Vavilovi, *Triticum vavilovii* Jakubz.
Wheat, Wild einkorn, *Triticum monococcum* L. subsp. *aegilopoides* (Link) Thell.
Wheat, Wild emmer, *Triticum turgidum* L. subsp. *dicoccoides* (Körn. ex Asch. & Graebn.) Thell.
Wheatgrass, intermediate, *Iseilema prostratum* (L.) Andersson
Wild rice, *Zizania palustris* L.
Wild rice, Eastern, *Zizania aquatica* L.
Cultivars, varieties, and hybrids of these commodities.

REFERENCES:

ADAMS: Adams, C.F. 1975. Nutritive Value of American Foods in Common Units. USDA ARS Agricultural Handbook No. 456.

ADEWALE: Adewale, D.B. & D.J. Dumet. Descriptors for African yam bean, Sphenostylis stenocarpa (Hochst ex. A. Rich.) Harms. IITA. Research to Nourish Africa. http://www.iita.org/c/document_library/get_file?uuid=616ec328-9e67-46eb-86bb-08b22795e4f2&groupId=25357

AGGIE-HORT: Texas A&M, Department of Horticultural Sciences, AgriLife Extension website: [HYPERLINK "http://aggie-horticulture.tamu.edu"]

AGMRC: The Agricultural Marketing Resource Center website: http://www.agmrc.org

AGRIHORTICO: Agrihortico – Empowering gardening and horticulture, informational website. [HYPERLINK "http://myagrihortico.com/index.php"]

AGRISK: The Ag. Risk Education Library, University of Minnesota. [HYPERLINK "http://www.agrisk.umn.edu"]

AGROHAITAI: Agrohaitai, Ltd., Oriental Vegetable Seeds [HYPERLINK "http://www.agrohaitai.com"]

AHMED: Ahmed, A. and K. Johnson. 2000. Horticultural Development of Australian Native Edible Plants. Australian J. Botany 48: 417-426.

ALI: Ali, N., Yeap, S., Ho, W., Beh, B., Tan, S., & Tan, S. (2012). The Promising Future of Chia, Salvia hispanica L. *Journal of Biomedicine and Biotechnology*. Retrieved August 11, 2014, from [HYPERLINK "http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3518271/pdf/JBB2012-171956.pdf"]

ALLEN 2007. Allen, G. 2007. The Herbalist in the Kitchen. 483 pp. University of Illinois Press.

ALUKA: Aluka: A digital library of scholarly resources from and about Africa. [HYPERLINK "file:///\\\\ir4files\\shared\\KATHRYN%20Homa\\Crop%20Grouping\\Tropicals\\www.aluka.org"].

AMERICAN BOTANICAL COUNCIL: ABC. 2015. [HYPERLINK "http://cms.herbalgram.org/herbclip/pdfs/121581-151.pdf"]

AMOATEY: Amoatey, H.M., Klu, G.Y.P., Bansa, D., Kumaga, F.K., Aboagye, L.M., Benett-Lartey, S.O. & Gamedoagbao, D.K. 2000. The African yam bean (Sphenostylis stenocarpa): A neglected crop in Ghana. West African Journal of Applied Ecology. 1:53-60.

ANBG: The Australian National Botanic Garden, Centre for Australian National Biodiversity Research website: [HYPERLINK "http://www.anbg.gov.au/"]

ANBG-WFHC: Australian National Botanic Gardens, Water for a Healthy Country Website. [HYPERLINK "http://www.anbg.gov.au/cpbr/WfHC"]

ANDERSON: Anderson, P., E. Oelke, and S. Simmions. 1995. Growth and Development Guide for Spring Barley. Univesity o Wisconsin Extension Service. FO-2547-D-GO.

ANISKO: Anisko, T. 2008. When Perennials Bloom: An Almanac for Planning and Planting. 510 pp. Timber Press. Accessed via Google Books 11/2/09.

ARTAUD: Artaud, Carlos R. . "Botany Section-Florida Department of Agriculture and Consumer Services-Division of Plant Industry." TRI-OLOGY 41, No. 3May to June 2002 Web.14 Aug 2009. [HYPERLINK "http://www.doacs.state.fl.us/pi/enpp/triology/archive/02-may-june.html"].

AUBURN: Romancing the velvet bean – Old flame of southern farmers may make a comeback. Auburn University. Office of Ag Communications & Marketing. http://www.ag.auburn.edu/comm/news/1997/velvetbean.php

AUSSIE GARDENING: Aussie Gardening website. [HYPERLINK "http://www.aussiegardening.com.au/"]

AUSTIN 2004: Austin, D. F. 2004. Florida Ethnobotany. 909 pp. CRC Press.

AVRDC: AVRDC – The World Vegetable Center website. [HYPERLINK "http://www.avrdc.org/"]

AWIKA: Awika, J. (November 30, 2011). Major Cereal Grains Production and Use around the World. Retrieved August 11, 2014 from [HYPERLINK "http://pubs.acs.org"]

BACKYARD GARDENER: Backyard Gardener website: Your gardening source since 1996. [HYPERLINK "http://www.backyardgardener.com/"]

BAILEY 1916. Bailey, L. H. 1916. Standard Cyclopedia of Horticulture, Vol. 2. The Macmillan Co. [HYPERLINK "http://chestofbooks.com/gardening-horticulture/Cyclopedia-2/index.html"]

BALTENSPERGER: Baltensperger, David D. "Foxtail and Proso Millet." In *Progress in New Crops.* Edited by Jules Janick. Alexandria, Va.: ASHS Press, 1996.

BAREJA: Bareja, Ben G. "What Are Cereal Crops and Pseudocereals, Examples." Crop Farming Review. January 1, 2010. http://www.cropsreview.com/cereal-crops.html.

BARRETT: Barrett, R. 1990. Legume Species as Leaf Vegetables. PP. 391-396. In J. Janick and J. Simon, eds. Advances in New Crops. Timber Press. Portland OR.

BAYFLORA: Bayflora. 2015. [HYPERLINK "http://bayflora.com/magnoliavine.html"]

BENEDICT: Benedict, C., Miles, C., & Johnson, S. Washington State University. 2012. Vegetables fodder & forage crops for livestock production: Fodder beets. Fact Sheet FS053E.

BITZER 1987: Bitzer, M. 1987. Production of Sweet Sorghum for Syrip in Kentucky. University of Kentucky College of Agriculture Cooperative Extension Service. AGR-122.

BITZER 1988: Bitzer, M. and J. Fox. 1988. Part II. Processing Sweet Sorghum for Syrup. U University of Kentucky College of Agriculture Cooperative Extension Service. AGR-123.

BioNET-EAFRINET: [HYPERLINK "http://keys.lucidcentral.org/keys/v3/eafrinet/weeds/key/weeds/Media/Html/Parthenium_hysterophorus_(Parthenium_Weed).htm"]

BORN: Born, H. 2006. Edamame: Vegetable Soybean. (https://attar.ncat.org/attar-pub/viewhtma.php?id=28.

BOTANICALAUTHENTICATION.ORG [HYPERLINK "http://www.botanicalauthentication.org/index.php/Smilax_aristolochiifolia_(root)"]

BOTANY: Botany.com website. [HYPERLINK "http://www.botany.com"]

BRENNER: Brenner, David M., et al. 2000. "Genetic Resources and Breeding of Amaranthus." In Plant Breeding Reviews, vol. 19. Edited by Jules Janick. [HYPERLINK "https://www.encyclopedia.com/places/united-states-and-canada/us-political-geography/new-york"]: John Wiley & Sons, Inc.

BRITANNICA: The Encyclopedia Britannica Online: [HYPERLINK "http://www.britannica.com/"]

CAL-IPC: California Invasive Plant Council website. [HYPERLINK "http://www.cal-ipc.org/"]

CARLETON: Carleton, Mark Alfred. 1923. The Small Grains. Edited by L. H. Bailey. [HYPERLINK "https://www.encyclopedia.com/places/united-states-and-canada/us-political-geography/new-york"]: Macmillan

CHAPMAN: Chapman, S.R. and Carter, L.P. 1976. Crop Production and Practices. San Francisco: W.H. Freeman and Co. pp. 247-258.

CAUDICIFORMS: Bihrmann's Caudiciforms Informational Website: [HYPERLINK "http://www.bihrmann.com/Caudiciforms/div/menu.asp"]

CHIA: Chia. (2012). University of Kentucky - Cooperative Extension Service. Retrieved August 11, 2014, from [HYPERLINK "http://www.uky.edu/Ag/CCD/introsheets/chia.pdf"]

CHILEFLORA: Chileflora website: Your window to the world of Chilean Plants. [HYPERLINK "http://www.chileflora.com/"]

CHINESE FOOD: About.com's Chinese food reference website. [HYPERLINK "http://chinesefood.about.com/"]

COGLIATTI: Cogliatti, M. 2012. Canaryseed Crop. Scientia Agropecuaria. 1:75-88.

CONRAD: Conrad, H. R., and F. A. Martz. 1985. "Forages for Dairy Cattle." In Forages, The Science of Grassland Agriculture. 4th ed. Edited by Maurice E. Heath, Robert F. Barnes, and Darrel S. Metcalfe. Ames: Iowa State University Press, 1985.

COOKSFRESHMARKET: Cooks Fresh Market, Downtown Denver's Quality Corner Market website: [HYPERLINK "http://www.cooksfreshmarket.com/index.html"]

COSEWIC:
[HYPERLINK "http://www.registrelep-sararegistry.gc.ca/virtual_sara/files/cosewic/sr_Redroot_0810_e1.pdf"]

COUNTRY LOVERS: Country Lover's Wild Food School website: [HYPERLINK "http://www.countrylovers.co.uk/wfs/index.htm"]

COGLIATTI: Cogliatti, M. 2012. Canaryseed Crop. Scientia Agropecuaria. 1:75-88.

CRUA: Cruz, J. (2004). Fonio: A small grain with potential. LEISA Magazine, (20)1. Retrieved August 11, 2014, from http://www.agriculturesnetwork.org/magazines/global/valuing-crop-diversity/fonio-a-small-grain-with-potential

DIET AND HEALTH: Diet and Health natural remedies and nutrition website: [HYPERLINK "http://www.diet-and-health.net/Naturopathy/Burdock.html"]

DIVER: Diver, S. 2003. Sorghum Syrup. ATTRM.ncat.org.

ECOCROP: United Nations Food and Agriculture Organization Crop InformationWebsite: [HYPERLINK "http://ecocrop.fao.org/"]

ECOCROP: Plant Search Form. (1993-2007). Retrieved August 11, 2014, from [HYPERLINK "http://ecocrop.fao.org/ecocrop/srv/en/cropFindForm"]

ECOPORT: EcoPort biodiversity database: [HYPERLINK "http://ecoport.org/index.html"]

EDWARDSSON: Edwardson, Steven. 1996. "Buckwheat: Pseudocereal and Nutraceutical." In Progress in New Crops. Edited by Jules Janick. Alexandria, Va.: ASHS Press.

EFLORAS: Efloras.org. [HYPERLINK "http://www.efloras.org/index.aspx"] and http://www.efloras.org/florataxon.aspx?flora_id=2&taxon_id=200018575

ELZEBROEK 2008: Elzebroek, A. T.G and Koop Wind. 2008. Guide to Cultivated Plants. CABI. 540 pp.

ENSMINGER: Ensminger, M.E., J.L. Oldfield, and W.W. Heinemann. 1990. Feeds and Nutrition. 2nd Edition. Ensminger Publishing Co., Clovis, CA.

EOL: Encyclopedia of Life: Global Access to Knowledge About Life On Earth. [HYPERLINK "http://eol.org/"]

EPICUREAN. Epicurean: For Food and Wine Lovers website. [HYPERLINK "http://www.epicurean.com"]

ERS-USDA: Economic Research Service of the USDA website: [HYPERLINK "http://www.ers.usda.gov/"]

ETHNO-BOTANIK.ORG
http://www.ethno-botanik.org/Heilpflanzen/Plectranthus-barbatus/Boldo-Plectranthus-barbatus-en.html

FACCIOLA: Facciola, S. 1990. Cornucopia: A Source Book of Edible Plants. Kampong Pub. Vista, CA. 677 pp.

FAO: Grassland Species Profiles. Retrieved August 12, 2014, from [HYPERLINK "http://www.fao.org/ag/AGP/AGPC/doc/GBASE/Default.htm"]

FAO: [HYPERLINK "https://www.encyclopedia.com/social-sciences-and-law/political-science-and-government/united-nations/food-and-agriculture"] of the [HYPERLINK "https://www.encyclopedia.com/social-sciences-and-law/political-science-and-government/united-nations/united-nations"]. 1998. The State of the World's Plant Genetic Resources for Food and Agriculture. [HYPERLINK "https://www.encyclopedia.com/places/spain-portugal-italy-greece-and-balkans/italian-political-geography/rome"]: [HYPERLINK "https://www.encyclopedia.com/social-sciences-and-law/political-science-and-government/united-nations/food-and-agriculture"] of the [HYPERLINK "https://www.encyclopedia.com/social-sciences-and-law/political-science-and-government/united-nations/united-nations"].

FAO DOC: FAO Documents Repository [HYPERLINK "http://www.fao.org/documents/"]

FAO GRASS: Food and Agriculture Organization of the United Nations, Grassland Species Database: [HYPERLINK "http://www.fao.org/ag/AGP/AGPC/doc/Gbase/Default.htm"]

FAOSTAT, Food and Agriculture Organization of the United Nations. [HYPERLINK "http://faostat.fao.org/site/567/DesktopDefault.aspx?PageID=567"]

FEEDIPEDIA: Animal feed resources information system. 2013. Available from: http://www.feedipedia.org/.

FEEDIPEDIA: Indian sandbur (Cenchrus biflorus). (2012-2013). Retrieved August 11, 2014, from [HYPERLINK "http://www.feedipedia.org/node/483"]

FLEPPC.ORG: http://www.fleppc.org/ID_book/pueraria%20montana.pdf

FLORA OF ZIMBABWE: Flora of Zimbabwe informational. . [HYPERLINK "http://www.zimbabweflora.co.zw/index.php"]

FORTIN: Fortin, J. 1996. The Visual Food Encyclopedia. Macmillan Co., NY. 685 pp.

FREEMAN: Freeman, K. 1986. Sweet Sorghum Culture and Syrup Production. USDA Agr. Handbook. No. 611..

GAIN: The Global Agricultural Information Network of the USDA Foreign Agricultural Service (FAS): [HYPERLINK "http://gain.fas.usda.gov"]

GARDEN-CENTRE: U.K. Garden Center information and seed catalogue: [HYPERLINK "http://www.garden-centre.org/"]

GEBBARDT: Gebhardt, S.E. and R. Matthews. 1986. Nutritive Value of Foods. USDA Human Nutrition Information Service. Home and garden Bulletin No. 72.

GEORGE: George, R.A.T. 2011. Tropical Vegetable Production.CABI International. UK. 225 pp.

GERIK: Gerik, T., B. Bean, and R. Vanderlip. 2003. Sorghum th and Development. Texas Cooperative Extenion Service. B-6137 7-03.

GLOBAL FACILITATION UNIT FOR UNDERUTILIZED SPECIES: Cañihua .[HYPERLINK "http://www.cropsforthefuture.org/publication/Species-brochure/Species%20brochure-%20Chenopodium%20pallidicaule.pdf"]

GLOBAL SPECIES: Global Species website species data from around the web: [HYPERLINK "http://www.globalspecies.org/"]

GOBOTANY: GOBOTANY. 2015. [HYPERLINK "https://gobotany.newenglandwild.org/species/rhodiola/rosea/"]

GOOSEFOOT, HUAUZONTLE, QUELITE, BLEDO: Goosefoot, Huauzontle, Quelite, Bledo. Retrieved August 12, 2014, from [HYPERLINK "http://www.texasbeyondhistory.net/st-plains/nature/images/chenopod.html"]

GRAMENE: Wild Rice *(Zizania* Nutrition. Retrieved August 12, 2014, from [HYPERLINK "http://archive.gramene.org/species/zizania/wildrice_nutrition.html"]

GRANBERRY: Granberry, D. T. Kelley, and G. Boyhan. 1999. Seeding Rates for Vegetable Crops. University of Georgia Cooperative Extension Service. Bulletin 1128.

GRASSES OF IOWA: Canarygrass: *Phalaris canariensis L.* Retrieved September 18, 2014, from [HYPERLINK "http://www.eeob.iastate.edu/research/iowagrasses/index.html"]

GRIN: Germplasm Resources Information Network, United States Department of Agriculture. [HYPERLINK "http://www.ars-grin.gov"]

GRIGSON 2007: Grigson, J. and Y. Skargon. 2007. Jane Grigson's Vegetable book. 607 pp. University of Nebraska Press.

GRIMES HORT: Grime Horticulture website. [HYPERLINK "http://www.grimes-hort.com"]

GRUBBEN 2004b: GRUBBEN 2004: Grubben G. J. H. and O. A. Denton. 2004. Plant Resources of Tropical Africa 2: Vegetables. 668 pp. Backhuys Publishing, Leiden, Netherlands.

HARDENBURG: Hardenburg, R.E., A.E. Wataba, and C.I. Wang. 1986. The Commercial Storage of Fruits, Vegetables, and Nursery Stocks. USDA Ag. Handbook Number 66. 130 pp.

HITCHOCK: Hitchcock, A. S. 1971. Manual of the Grasses of the [HYPERLINK "https://www.encyclopedia.com/places/united-states-and-canada/us-political-geography/united-states"]. Revised by Agnes Chase. Vols. 1–2. [HYPERLINK "https://www.encyclopedia.com/places/united-states-and-canada/us-political-geography/new-york"]:.Dover Publications, Inc.

HORN: Horn, F. P. "Cereals and Brassicas for Forage. 1985" In Forages: The Science of Grassland Agriculture. 4th ed. Edited by Maurice E. Heath, Robert F. Barnes, and Darrel S. Metcalfe. Ames: Iowa State University Press.

HORTWISC: Wisconsin Master Gardener Program Website. [HYPERLINK "http://www.hort.wisc.edu/mastergardener/"]

HU 2005: Hu Shiu-ying. 2005. Food Plants of China. 928 pp. Chinese University Press.

IEWF: International Environmental Weed Foundation website. [HYPERLINK "http://www.iewf.org"]

IFAS-EDIS: University of Florida, IFAS Extension, Electronic Data Information Service website: [HYPERLINK "http://edis.ifas.ufl.edu"]

INCAS: National Research Council (U.S.). Advisory Committee on Technology Innovation. 1989. Lost crops of the Incas: little-known plants of the Andes with promise for worldwide cultivation. 415 pp. National Acadamies. [HYPERLINK "http://www.nap.edu/openbook.php?record_id=1398&page=1"]

INDEXMUNDI: IndexMundi, commodity statistics by country. [HYPERLINK "http://www.indexmundi.com/"]

IPMCENTERS: National information system for the regional IPM centers, crop profiles website: [HYPERLINK "http://www.ipmcenters.org/cropprofiles/"]

IUCN RED LIST: [HYPERLINK "http://www.iucnredlist.org/"]

JOHNSON: Johnson, J., R. Lee, and R. Barnet. 200 Wheat Growth and Development. University of Georgia.

JSTOR PLANTS: JSTOR Plant Science website. [HYPERLINK "http://plants.jstor.org/"]

KENT: Kent, N. L., and A. D. Evers, eds. 1994. Kent's Technology of Cereals. Exeter, U.K.: 1994.

KUEPPER: Kuepper, G. 1992. Sweet Sorghum. Production and Processing. Kerr Center for Sustainable Agriculture. Poteau. OK.94pp.

LANCASHIRE, P. D., H. BLEIHOLDER, P. LANGELÜDDECKE, R. STAUSS, T. VAN DEN BOOM, E. WEBER und A. WITZEN-BERGER, 1991: A uniform decimal code for growth stages of crops and weeds. Ann. Appl. Biol. 119, 561-601.

LANTICAM: Lantican, R.M. 2001. The Science and Practice of Crop Production. UPLB, College, Los Baños, Laguna: SEAMEO SEARCH and UPLB. Pp. 4-5

LEE: Lee, R. 2001. Intensive Wheat Management in Georgia. University of Georgia Cooperative Extension Service.

Leonard: Leonard, Warren H., and John H. Martin. 1963. Cereal Crops. New York and London: Macmillan and Collier-Macmillan Ltd.

LIM: Lim, Tong K. 2013. Edible medicinal and non-medicinal plants. Dordrecht Netherlands New York: Springer, 2013.

LINARES: Linares, O. (2002). African Rice (Oryza glaberrima): History and Future Potential. *Proceedings of the National Academy of Sciences of the United States of America*, (25). 16360.

LIPID LIBRARY: The AOCS Lipid Library: Lipid Chemistry, Biology, Technology & Analysis. [HYPERLINK "http://lipidlibrary.aocs.org/index.html"]

LIVINGSTON: Livington, S. and C. Coffman. Syrup Sorghum for Texas. Texas Agriculture Extension Service. Texas A7M. L-5146.

LOCAL HARVEST: Local Harvest informational [HYPERLINK "http://www.localharvest.org/"]

LORENZ: Lorenz, O.A. and D.N. Maynard. 1988. Knott's Handbook for Vegetable Growers, 3rd Edition. Wiley-Interscience Publications: New York. 456 pp.

LORENZI: Lorenzi, H.J. and Jeffery, L.S. (1987). Weeds of the United States and Their Control. Van Nostrand Reinhold Company, New York.

LOST CROPS OF AFRICA: National Research Council (U.S.). Board on Science and Technology for International Development. 2006. Lost Crops of Africa: Vegetables. 352 pp. National Academies Press.

LUNT 1996: Lunt, I. D. A transient soil seed bank for the yam daisy, Microseris scapigera. The Victorian Naturalist 113(1) 1996, pp 16-19. LUSAS: Lusas, E.W. 2000. Oilseeds and oil-bearing materials. In Handbook of Cereal Science and Technology. K. Kulp and J. G. Ponte, Jr. (Ed.), Marcel Dekker, Inc., New York, pp. 297-362.

LUSAS: Lusas, E.W. 2000. Oilseeds and oil-bearing materials. In andbook of Cereal Science and Technology. K. Kulp and J. G. Ponte, Jr. (Ed.), Marcel Dekker, Inc., New York, pp. 297-362

MAGNESS: Magness, J.R., Markle, G.M. and Compton, C.C., 1971. Food and Feed Crops of the United States. Interregional Research Project IR-4, IR Bulletin No. 1

MAJORS: Majors, Kenneth R. "Cereal Grains as Food and Feed.1952. " In Crops in Peace and War: The Yearbook of Agriculture 1950–1951. Edited by Alfred Stefferud. Washington, D.C.: U.S. Government Printing Office.

MANSFELD: Hanelt, P. and Institute of Plant Genetics and Crop Plant Research (Eds.) 2001. Mansfeld's Encyclopedia of Agricultural and Horticultural Crops: (Except Ornamentals). 3700 pp. First Edition. Springer Publishing. New York, NY.

MARKLE: Markle, G.M., J.J. Baron, and B.A. Schneider. 1998. Food and Feed Crops of the United States. 517 pp. Second Edition. MeisterPro Reference Guides. Willoughby, Ohio

MASK: Mask, P. 1991. Sweet Sorghum and Syrup Production. University of Tennessee. ANR-625.

MATTHEWS: Matthews, R. and Y.Y. Garrison. 1975. Food Yields. Summary by Stages of Preparation Commonly Used. USDA ARS Handbook No. 102.

MYERS: Myers, Robert L. 1996. "Amaranth: New Crop Opportunity." In Progress in New Crops. Edited by Jules Janick. Alexandria, Va.: ASHS Press, 1996.

NASS: National Agricultural Statistics Service, USDA. [HYPERLINK "http://www.nass.usda.gov"]

OELKE: Oelke, E., Oplinger, E., & Brinkman, M. (1989). Triticale. *Alternative Field Crops Manual*. Retrieved August 13, 2014, from [HYPERLINK "https://www.hort.purdue.edu/newcrop/afcm/triticale.html"]

OUTHOUSE: Outhouse, J.B., K.D. Johnson and C.L. Rhykerd. 2007. Managing and Utilizing Pasture and Harvested Forages for Sheep ID-153. [HYPERLINK "http://www.agry.purdue.edu/ext/forages/publications/ID-153.htm"]

PENNINGTON: Pennington, J.A.T. 1998. Bowes and Church's Food Values of Portions Commonly Used. 7th Edition. Lippincott, NY.

PERENNIALS: Heritage Perennials, Perennial Encylopedia Online: [HYPERLINK "http://www.perennials.com"]

PLANTS DATABASE: USDA, Natural Resources Conservation Services webpage. Plants Profiles. http://plants.usda.gov/index.html

PLANTS FOR A FUTURE: Phalaris canariensis Canary Grass. Retrieved October 7, 2014, from [HYPERLINK "http://www.pfaf.org/user/Plant.aspx?LatinName=Phalaris+canariensis"]

PLANTS FOR A FUTURE: Coix lacryma-jobi - L. (1996-2012). Retrieved August 12, 2014, from [HYPERLINK "http://www.pfaf.org/user/Plant.aspx?LatinName=Coix+lacryma-jobi"]

PLANTS FOR A FUTURE: Chenopodium pallidicaule. Retrieved December 22, 2014, from [HYPERLINK "http://www.pfaf.org/user/Plant.aspx?LatinName=Chenopodium+pallidicaule"]

PLANTSRESCUE.COM
[HYPERLINK "http://www.plantsrescue.com/tag/hydrangea-hortensia/"]

PLANTZAFRICA: A website hosted by the South African National Biodiversity Institute. [HYPERLINK "http://www.plantzafrica.com"]

PRESCOTT: Prescott, J.M., P.A. Burnett, E.E. Saari, J. Ransom, J. Bowman, W. de Milliano, R.P. Singh and G. Bekele. 1986. Wheat diseases and pest. A guide for field identification. International Maize and Wheat Improvement Center: Mexico.

PROTA: Protabase: web database on useful plants of Tropical Africa, [HYPERLINK "http://database.prota.org"]

PROTA: Limeum obovatum Vicary. (2006). Retrieved August 12, 2014, from [HYPERLINK "http://database.prota.org/PROTAhtml/Limeum%20obovatum_En.htm"]

PROTA4U: Cenchrus biflorus Roxb. Retrieved August 11, 2014, from [HYPERLINK "http://www.prota4u.info/protav8.asp?h=M4&t=Cenchrus,biflorus&p=Cenchrus+biflorus#Synonyms"]

PURDUE: Purdue Homepage, [HYPERLINK "http://www.hort.purdue.edu/newcrop/default.html"]

Purdue University. 2010, May. Dept. of Agricultural Extension. Principal Stored Grain Insects of Indiana. Extension Bulletin E-80-W. [HYPERLINK "http://extension.entm.purdue.edu/publications/E-80"].

PUTNAM ET AL.: Putnam, D.H., Oelke, E.A., Oplinger, E.S., Doll, J.D., & Peters, J.B. (1990). Annual Canarygrass. Alternative Field Crops Manual. https://www.hort.purdue.edu/newcrop/afcm/cangrass.html

ROTH: Roth, Greg, and D. J. Undersander, eds. 1995. Corn Silage Production, Management, and Feeding. Madison, Wis.: American Society of Agronomy.

SASKATCHEWAN AG: Saskatchewan agriculture, food, and rural development website. [HYPERLINK "http://www.agriculture.gov.sk.ca/"]

SAUER: Sauer, J. 1993. Historical Geography of Crop Plants. A Selected Roster. CRC Press. Boca Raton, FL. 309 pp. Simpson: Simpson, B. and M. Ogorzaly. 2001. Economic Botany. Plants in Our World. Third Ed. McGraw-Hill Co. NY. 528 pp.

SCHNEIDER: Schneider, Bernard A. 2002. Reviewer's Guide and Summary of HED ChemSAC Approvals for Amending Commodity Definitions [40 CFR 180.1(h)] and Crop Group/Subgroups [40 CFR 180.41. Through William Hazel and Hoyt Jamerson. US EPA. Jume 14.

SCHNEIDER 2001: Schneider, Elizabeth. 2001. Vegetables from Amaranth to Zucchini: The Essential Reference. 777 pp. HarperCollins, New York, NY.

SCHREIBER: Schreiber, Alan and Laura Ritchie. 1995. Washington Minor Crops. Washington State University Cooperative Extension Service, Pub No. MISC0181.

SPECIALTY PRODUCE: Specialty Produce website: [HYPERLINK "http://www.specialtyproduce.com/index"]

SPRAGUE: Sprague, G. F., and J. W. Dudley, eds. 1998. Corn and Corn Improvement. 3d ed. Madison, Wis.: American Society of Agronomy

STEPHENS 1994a: Stephen, J.M. 1994. Publication HS570 of the Florida Cooperative Extension Service, Institute of Food and Agricultural Sciences, University of Florida. [HYPERLINK "http://edis.ifas.ufl.edu/pdffiles/MV/MV03700.pdf"]

STEPHENS 1994b: Stephen, J.M. 1994. Publication HS609 of the Florida Cooperative Extension Service, Institute of Food and Agricultural Sciences, University of Florida. [HYPERLINK "http://edis.ifas.ufl.edu/pdffiles/MV/MV07600.pdf"]

STEPHENS 1998: Stephens, J.M. 1988. Manual of Minor Vegetables. Florida Cooperative Extension Bulletin SP-40. 123 pp.

STUBBENDIECK: Stubbendieck, James, Geir Y. Friisoe, and Margaret R. Bolick. Weeds of Nebraska and the [HYPERLINK "https://www.encyclopedia.com/places/united-states-and-canada/us-physical-geography/great-plains"]. Lincoln: Nebraska Department of Agriculture, 1994.

SUSTAINABLE SEED: Sustainable Seed Company website: [HYPERLINK "http://www.sustainableseedco.com"]

TROPICAL FORAGES: Fact Sheet. Macrotyloma uniflorum. [HYPERLINK "http://www.tropicalforages.info/key/Forages/Media/Html/Macrotyloma_uniflorum.htm"]

TROPICAL FORAGES: List of Forages. Retrieved August 13, 2014, [HYPERLINK "http://www.tropicalforages.info/key/Forages/Media/Html/index.htm"]

TROPILAB: Tropilab, Inc. Exporter and wholesaler of medicinal plants, herbs, tropical seeds, and cut flowers. [HYPERLINK "http://www.tropilab.com/"]

TULL 1999: Tull, D. 1999. Edible and Useful Plants of Texas and the Southwest: A Practical Guide. 542 pp. University of Texas Press. Accessed via Google Books 3/19/2010.

UGA EXTENSION: Lee, D., Hanna, W., Buntin, D.G., Dozier, W., Timper, P., & Wilson, J.P. Pearl Millet for Grain (B 1216). (2012). Retrived from [HYPERLINK "http://extension.uga.edu/publications/detail.cfm?number=B1216"]

USEFUL TROPICAL PLANTS: Oryza glaberrima. Retrieved September 22, 2014, from [HYPERLINK "http://tropical.theferns.info/viewtropical.php?id=Oryza+glaberrima"]

UNIVERSITY OF CALIFORNIA 1998: University of California (System). Division of Agriculture and Natural Resources. 1998. Specialty and Minor Crops Handbook. 184 pp. ANR Publications.

USDA 2010: USDA 2010. Agricultural Statistics. National Agricultural Statistics Service. US Government Printing Office. Washington, D.C.

USDA 2014a: USDA 2016. Agricultural Statistics. National Agricultural Statistics Service. US Government Printing Office. Washington, D.C. 486 pp.

USDA 2014B: Sheahan, C.M. 2014. Plant guide for foxtail millet (Setaria italica). USDA-Natural Resources Conservation Service, Cape May Plant Materials Center, Cape May, NJ. Retrived from [HYPERLINK "http://plants.usda.gov/plantguide/pdf/pg_seit.pdf"]

U.S. EPA. 1994. EPA Residue Chemistry Test Guidelines. Processed Food/Feed. OPPTS 860.1540

VAIL: Vail, Gladys E., Jean A. Phillips, Lucile Osborn Rust, Ruth M. Griswold, and Margaret M. Justin. *Foods: An Introductory College Course.* 6th ed. Boston: Houghton Mifflin, 1973.

WADAF: Government of Western Australia, Department of Agriculte and Food website.0020[HYPERLINK "http://www.agric.wa.gov.au/HOME.html?s=594811371"]

WAGONER: Wagoner, P. 1989. Grass or Grain?: Imtermediate Wheatgrass in a Perennial Cropping System for the Northern Graeat Plains. ND State University Agricture Experiment Station Research Report No. 108.

WEBMD: WebMD Medical Information website: [HYPERLINK "http://webmd.com"]

WHFOODS: World's Healthiest Foods website. [HYPERLINK "http://www.whfoods.com/"]

WHO: WHO Monographs On Selected Medicinal Plants. Vol. 1, elected Medicinal Plants. Geneva: World Health Organization, 1999

WHOLE GRAINS COUNCIL: Whole Grains, A to Z. (2003-2013). Retrieved August 11, 2014, from [HYPERLINK "http://wholegrainscouncil.org/whole-grains-101/whole-grains-a-to-z"]

WIKIPEDIA: Wikipedia, The Free Encyclopedia Online information. [HYPERLINK "http://en.wikipedia.org/wiki/Main_Page"]

YAMAGUCHI 1983: Yamaguchi, Mas. 1983. World Vegetables. AVI Publishing Company: Westport, Connecticut. 415 pp.

Item	Response for Database
Meeting Date	10/ /18
Presenter	Bernard A. Schneider, Ph D.
Chemical	None
Title	Crop Groupimg – Crop Grouping – Part XX: Analysis of the USDA IR-4 Petition to Amend the Crop ecommendations for Amending Crop Group 15 Cereal Grains and Crop Group 16 Forage, Fodder and Straw of Cereal Grains to Approve Its Members, Representative Commodities, Crop Subgroups, and Associated Commodity Definitions
Generic or Chemical Specific	N/A
Topic/Subject	Amend Crop Group
Guideline No.	40CFR 180.41 (22) and (23), OPPTS 860.1500
Crop Group/Livestock	Cereal Grain Group 15 and Forage, Fodder, and Straw of Cereal Grain Group 16
Crop/Livestock	Cereal Grain Group 15 and Forage, Fodder, and Straw of Cereal Grain Group 16
Commodity	Cereal Grians
Publically Releasable	Yes
Precedent Setting	Yes
IR-4 Item	Yes
PMRA Item	Joint review

APPENDICES

Figure 2. All Wheat for Grain, Harvested Acres, 2012, US Map

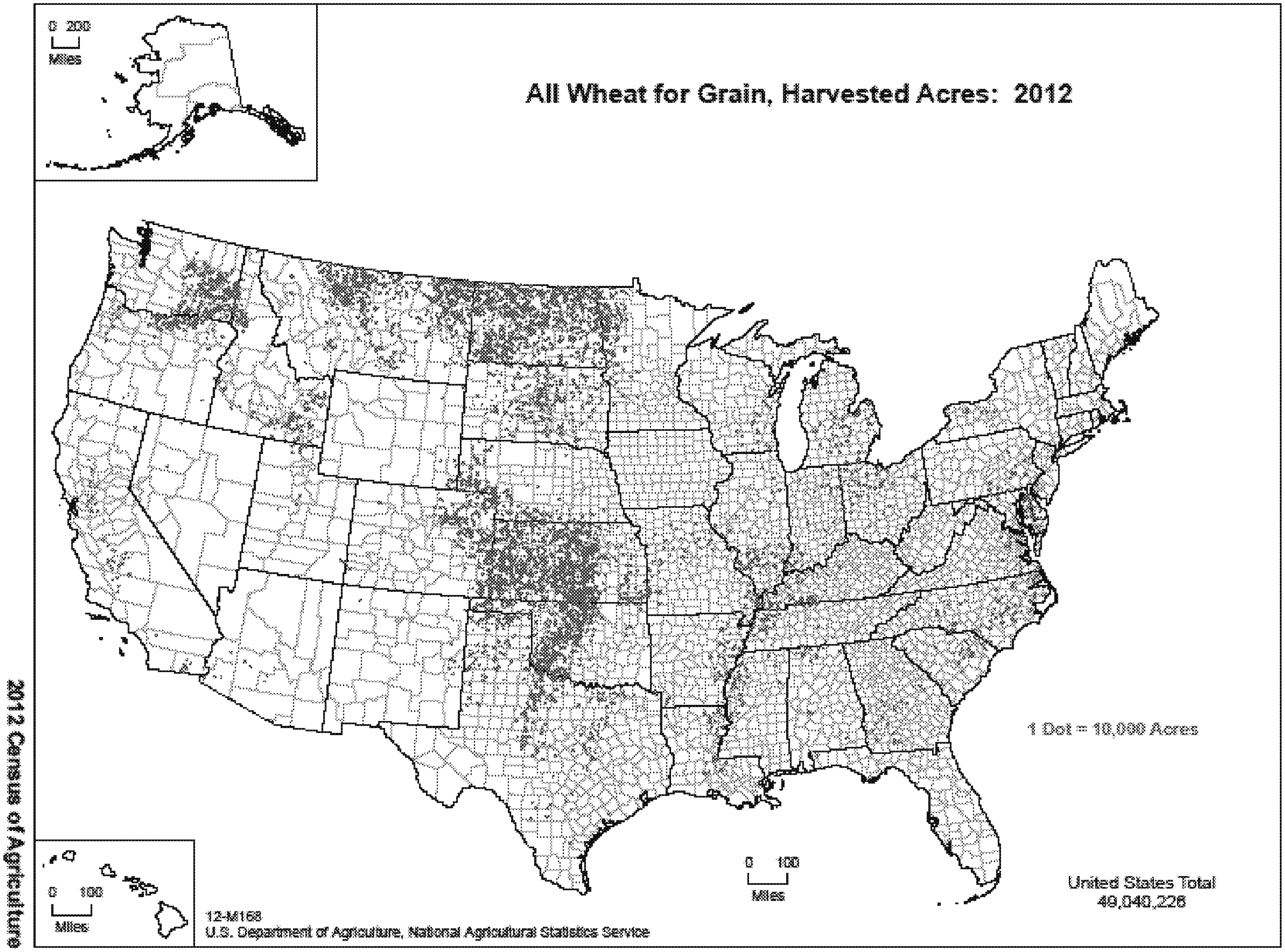


Figure 3. All Wheat Harvested for Grain, Change in Acreage, 2007 to 2012, US Map

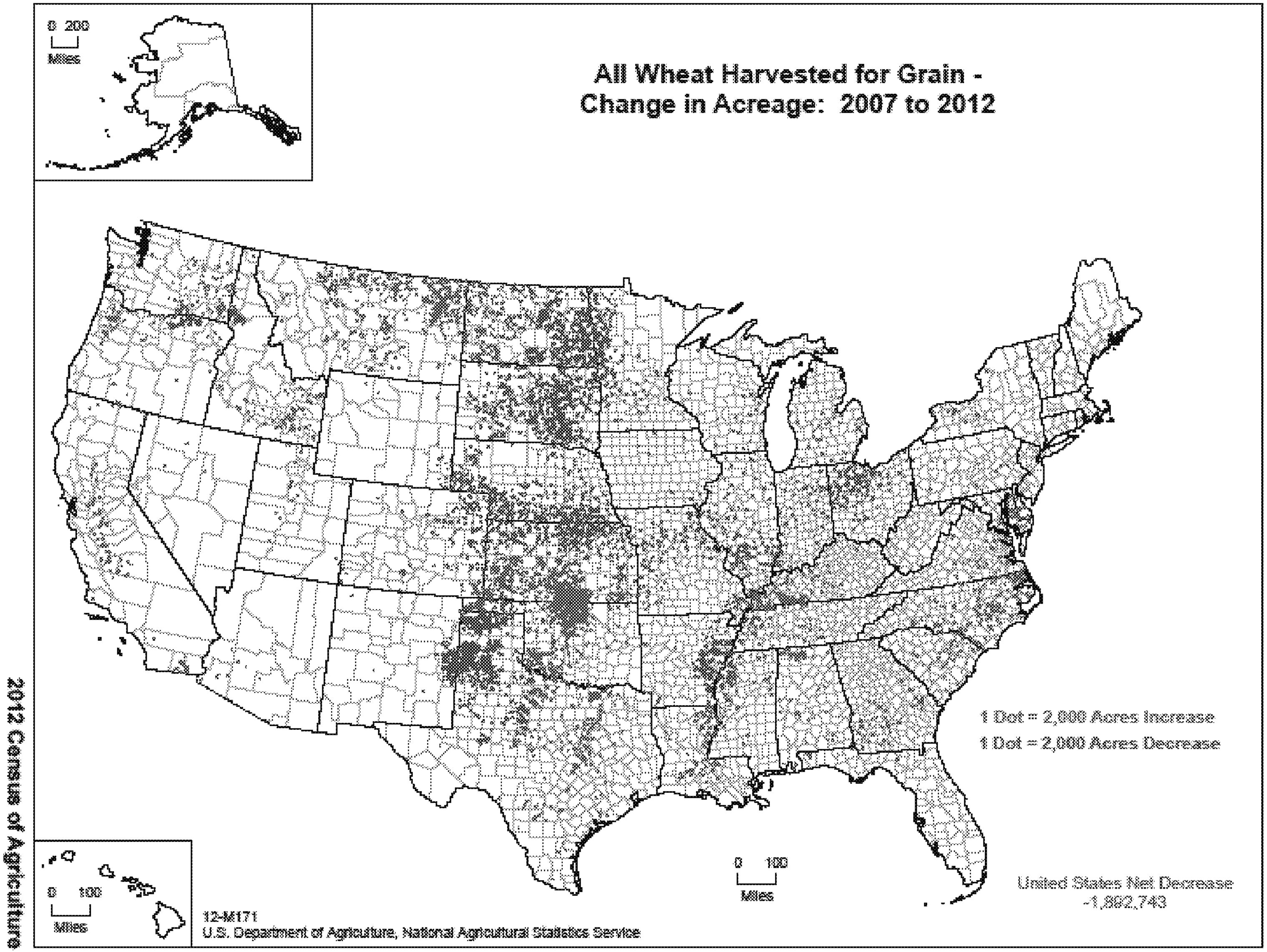


Figure 4. Barley for Grain, Harveted Acres, 2012, US Map

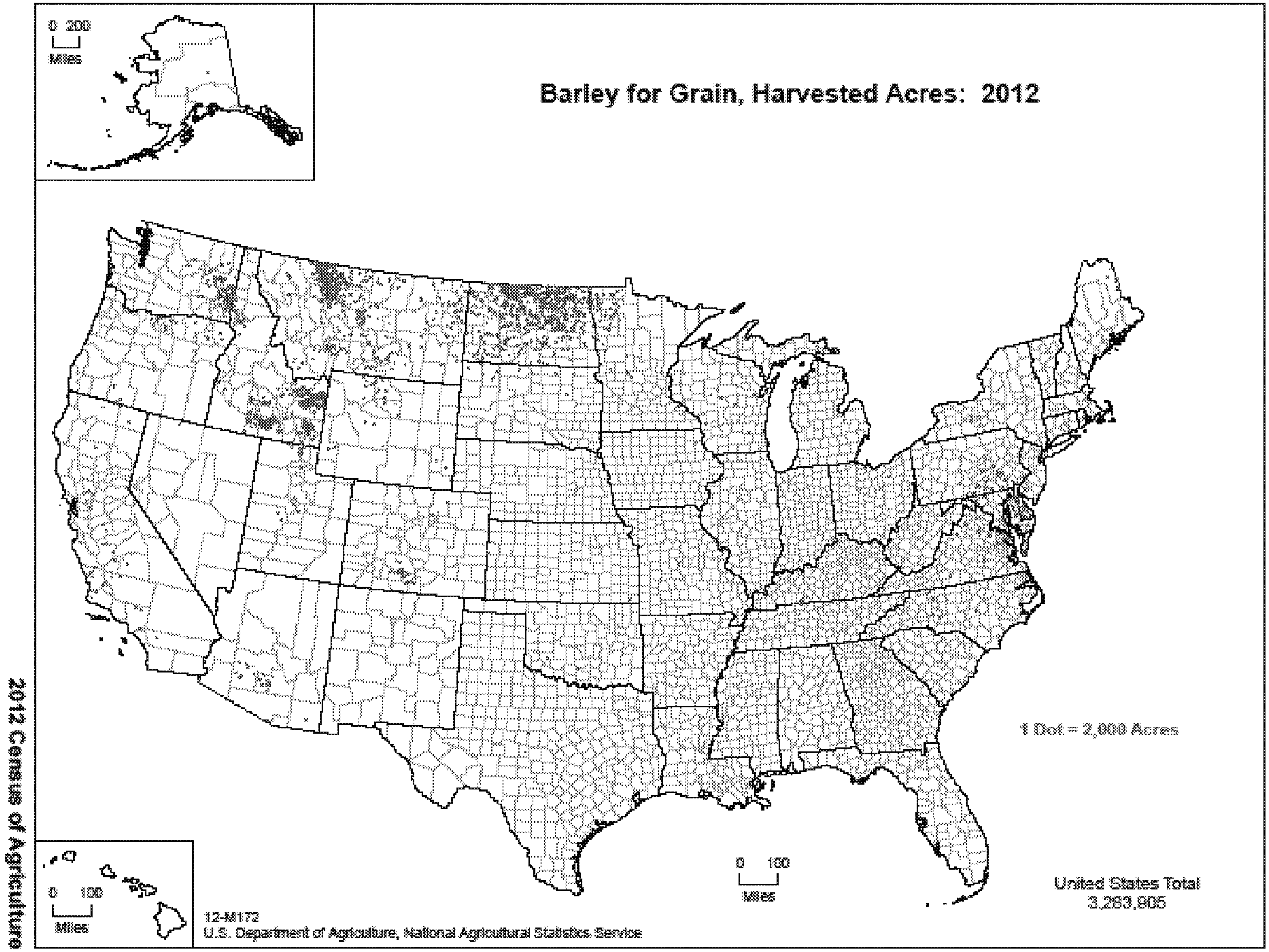


Figure 5. Barley Harvest for Grain, Change in Acreage, 2007 to 2012, US Map

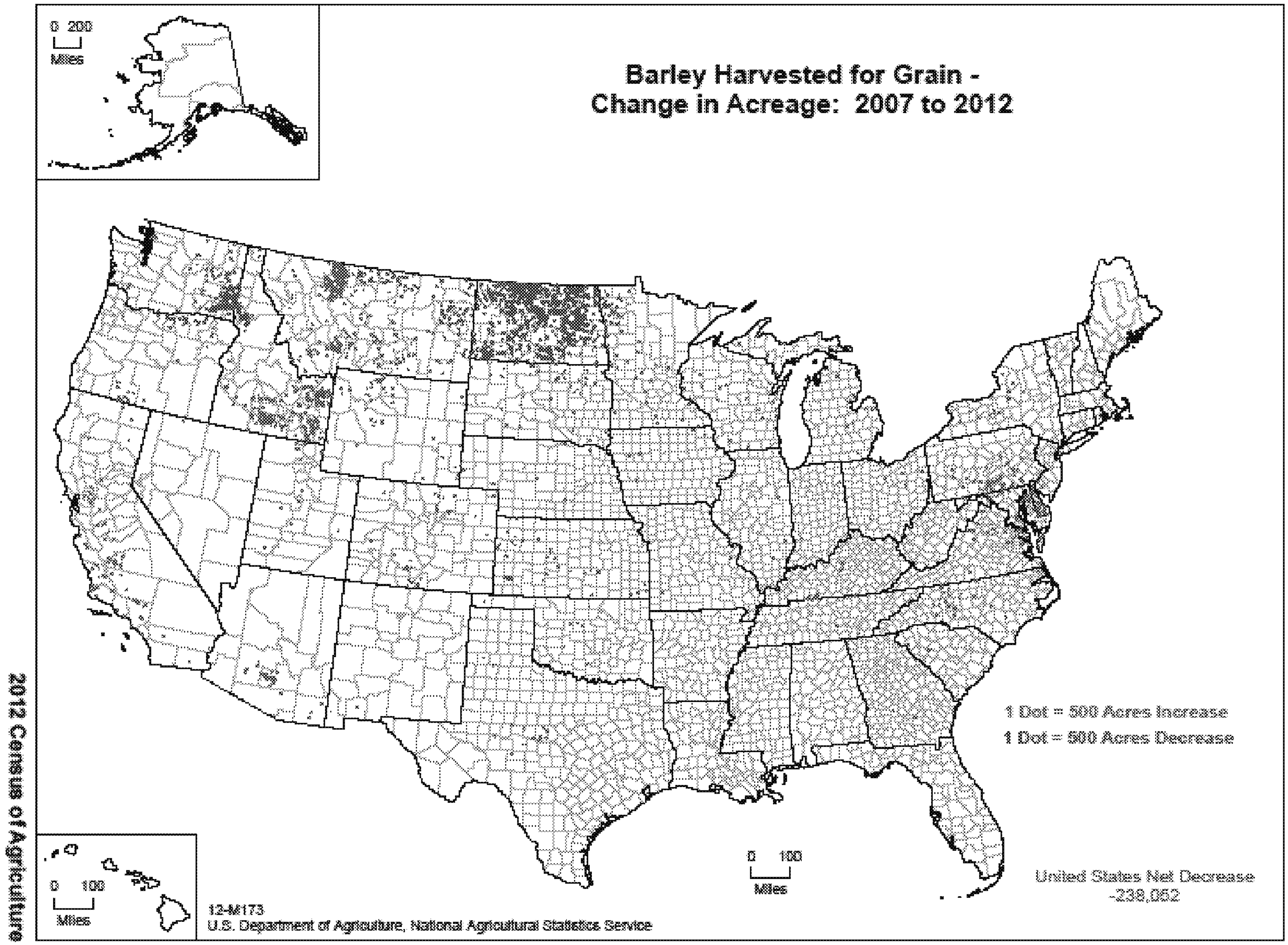
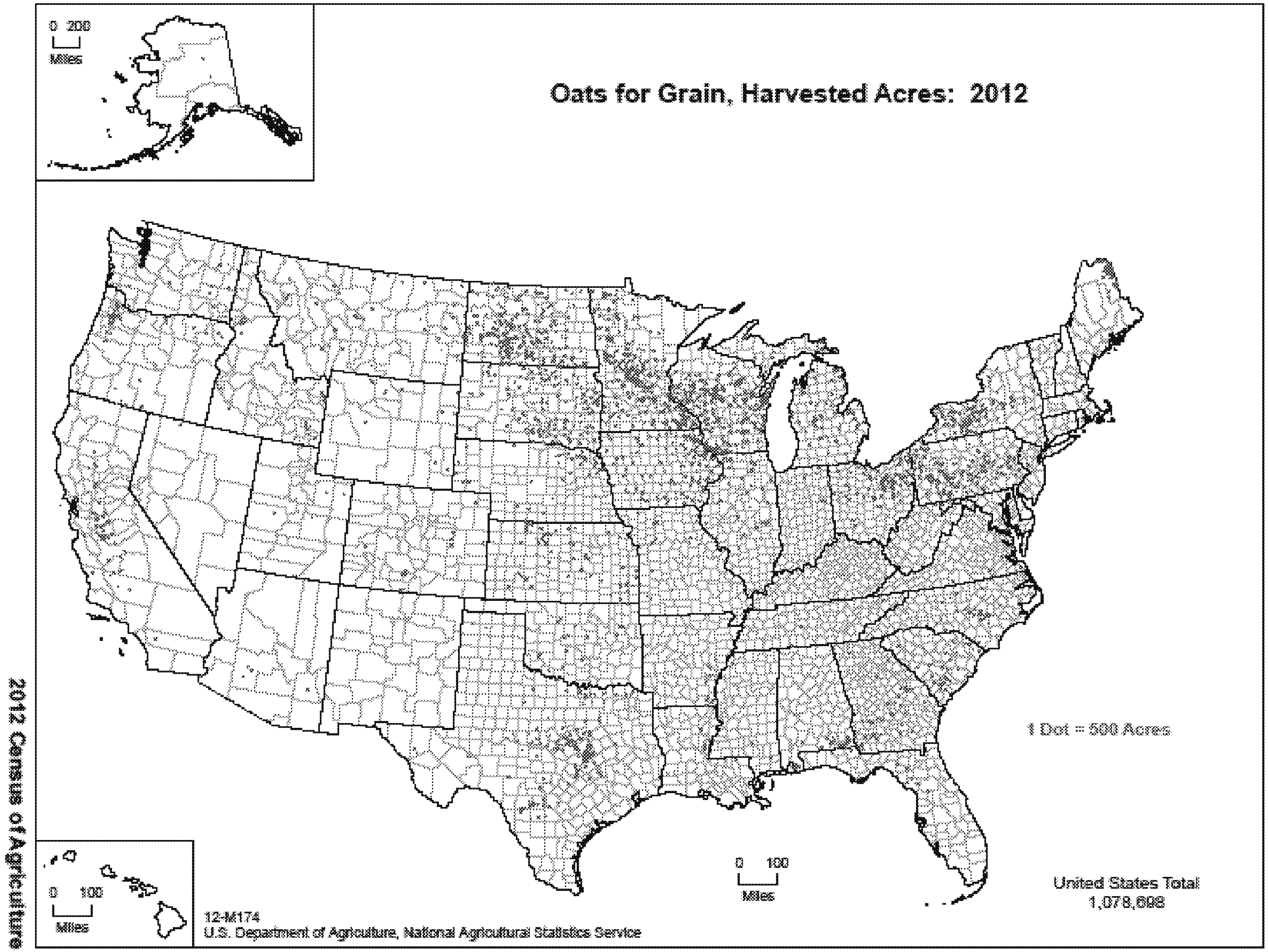


Figure 6. Oats for Grain, Harveted Acres, 2012, US Map



[PAGE * MERGEFORMAT]

Figure 7. Oats Harvested for Grain, Change in Acreage, 2007 to 2012, US Map

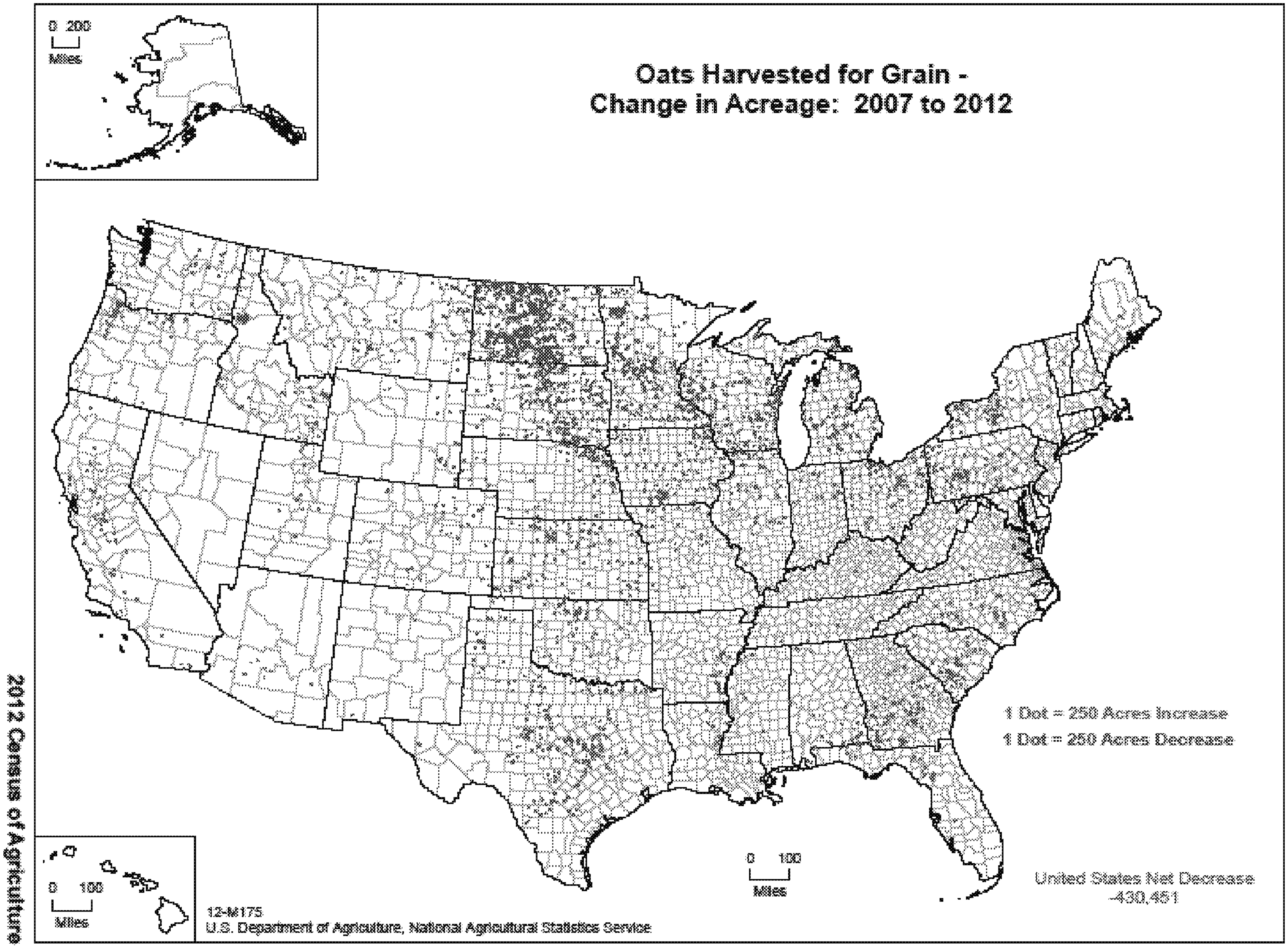


Figure 8. Rye for Grain, Harvested Acres, 2012, US Map

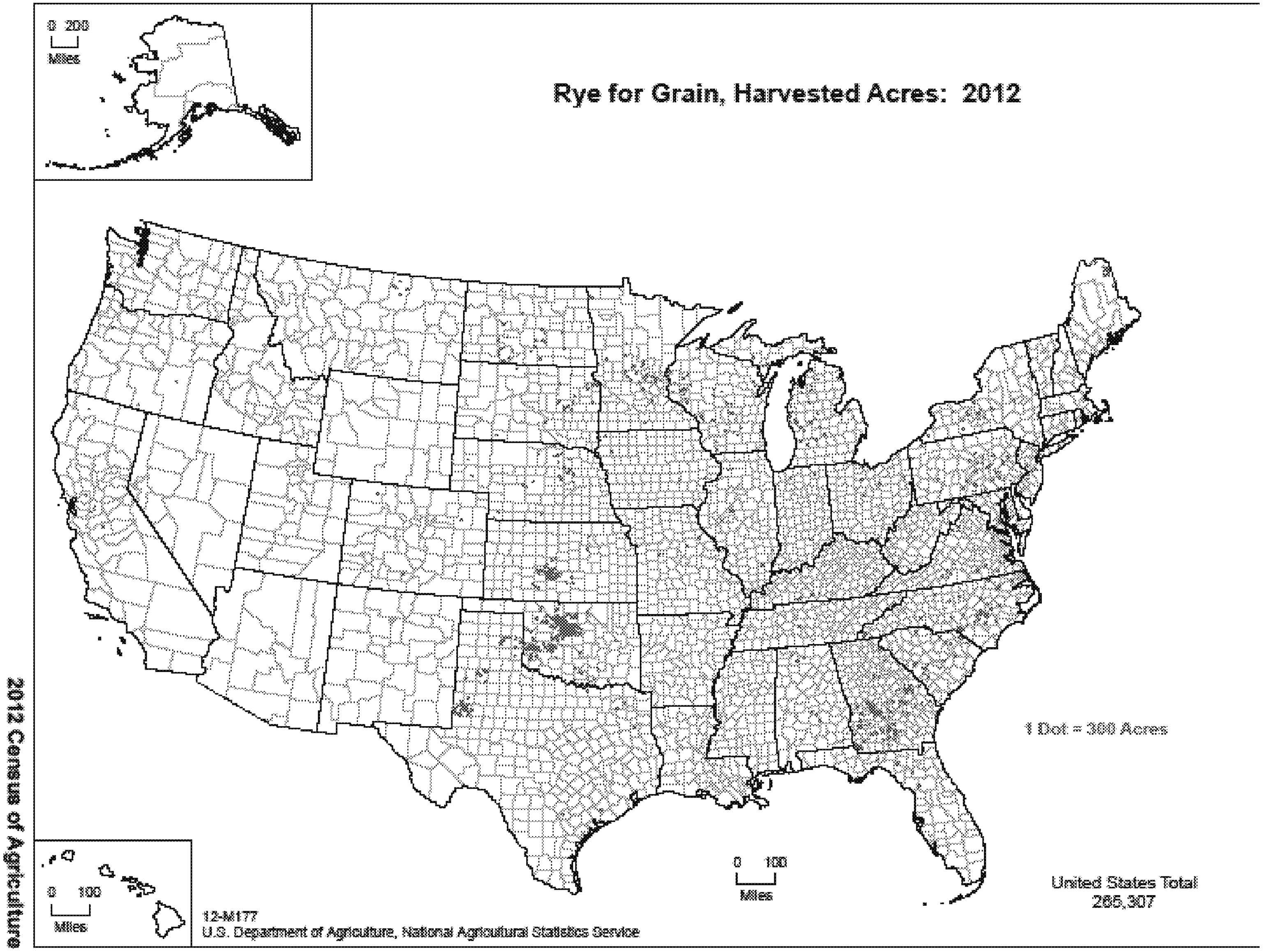


Figure 9. Corn for Grain, Harvested Acres, 2012, US Map

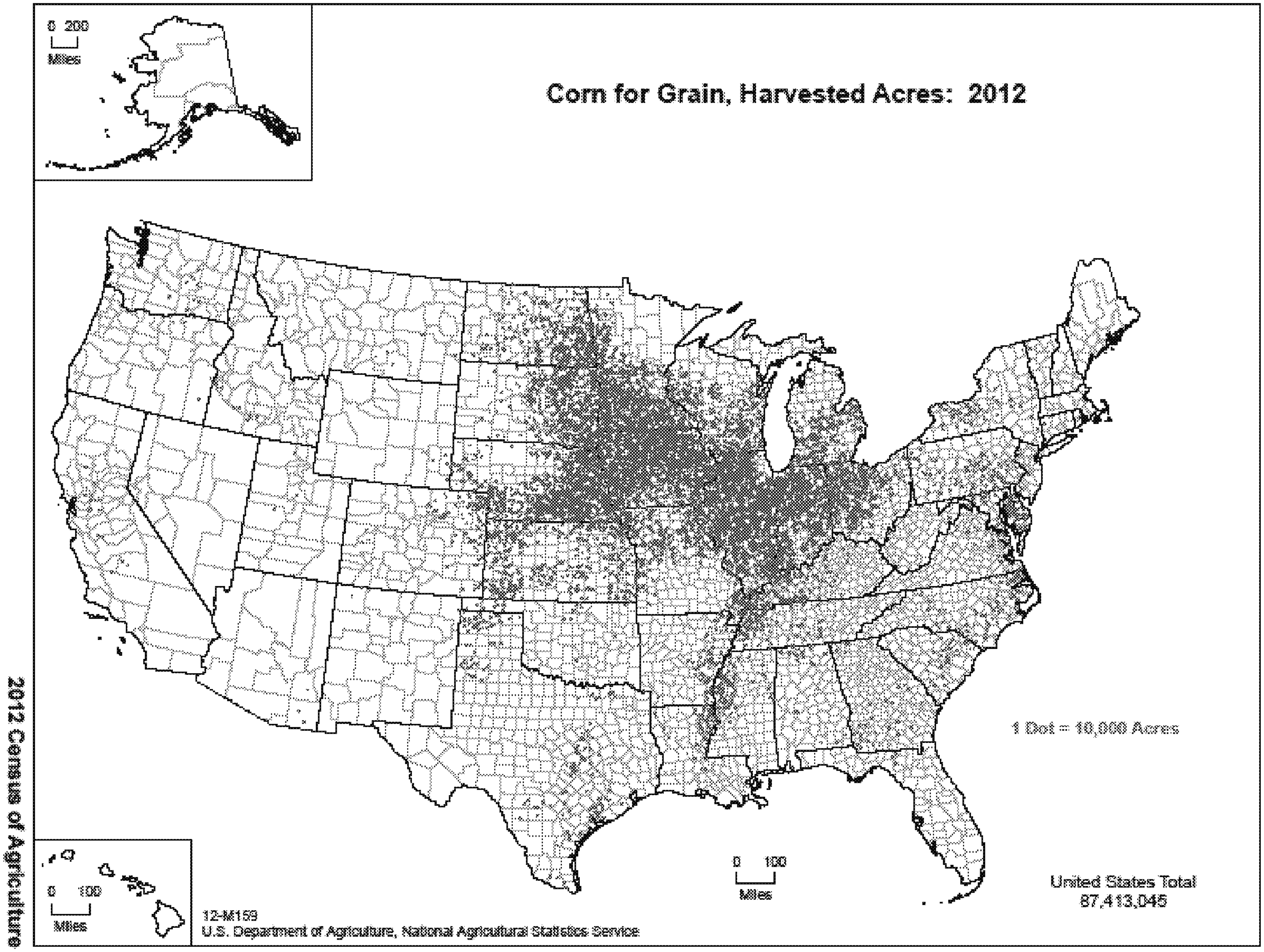


Figure 10. Corn Harvested for Grain, Change in Acreage, 2007 to 2012, US Map

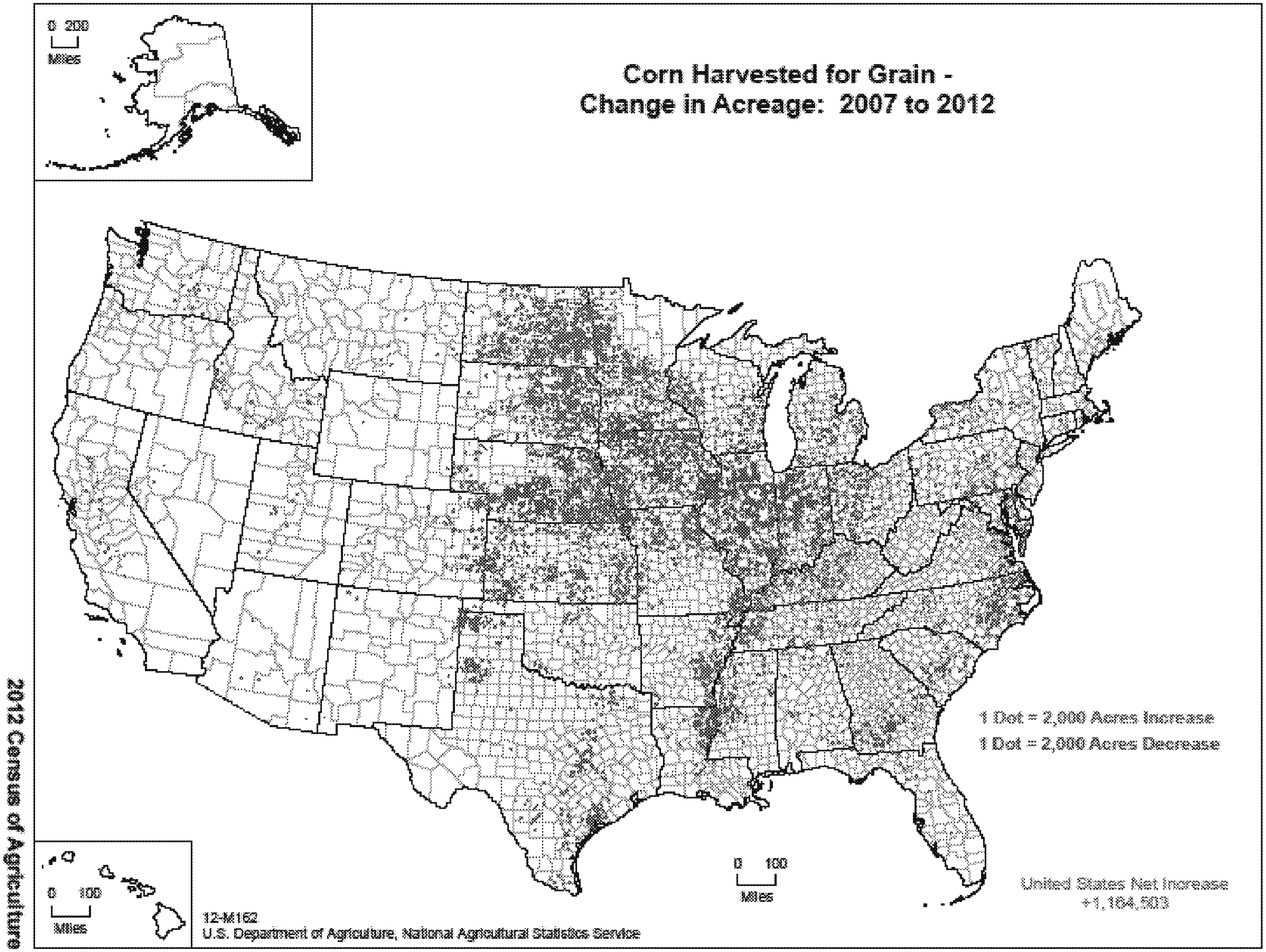


Figure 11. Sweet Corn, Acres Harvested for Sale, 2012, US Map

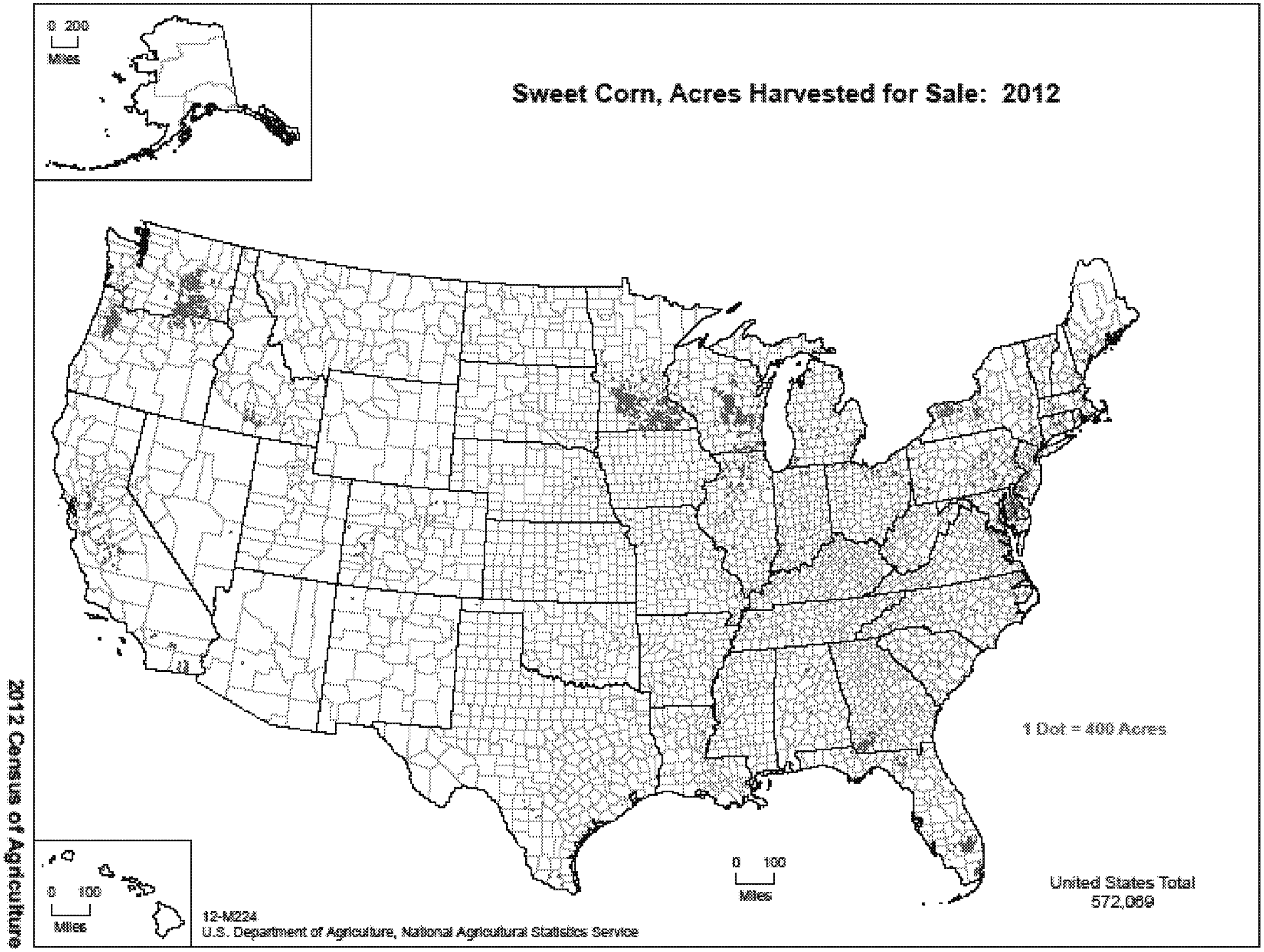


Figure 12. Sorghum for Grain, Harvested Acres, 2012, US Map

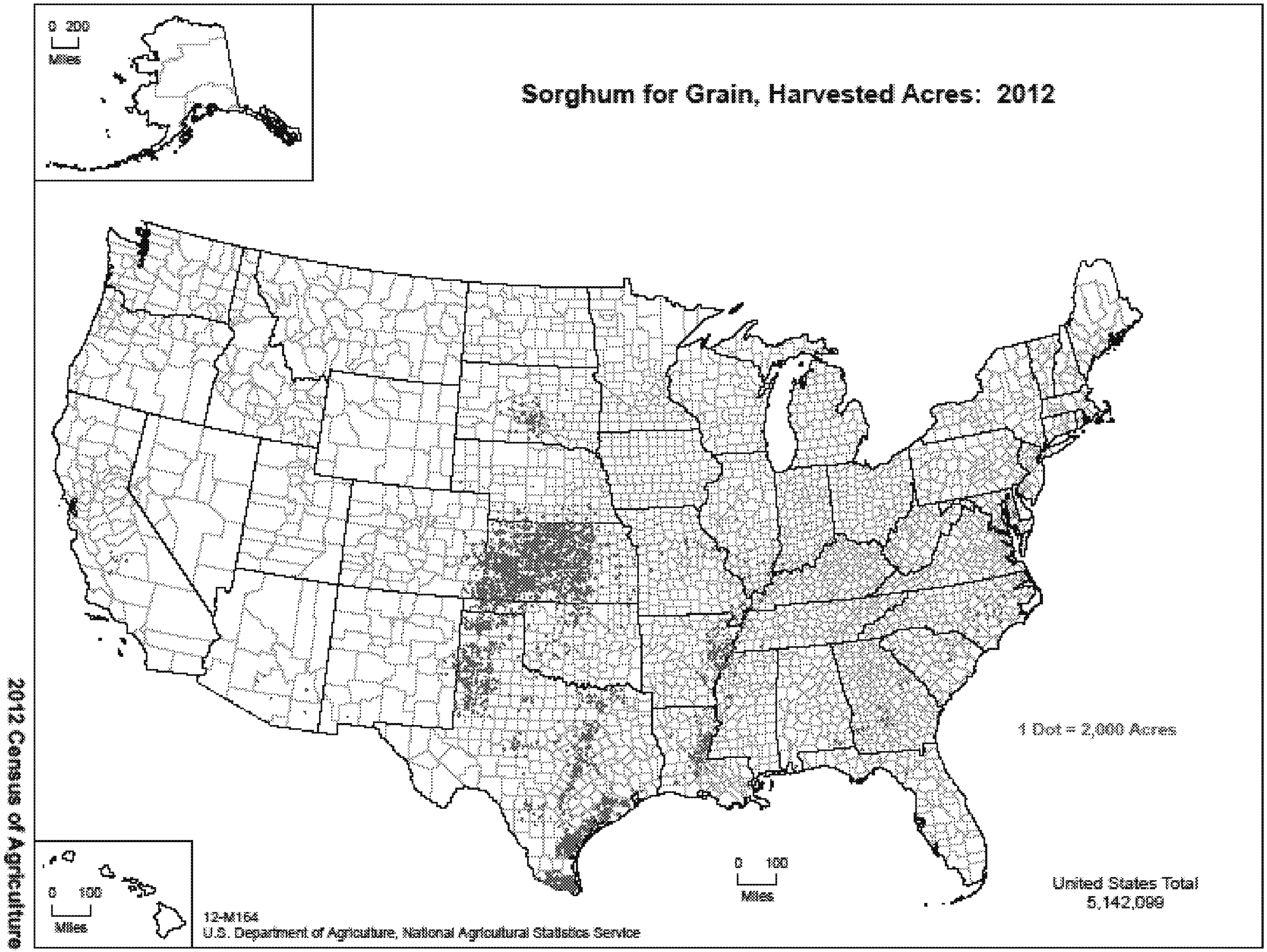


Figure 13. Sorghum Harvested for Grain, Change in Acreage, 2007 to 2012, US Map

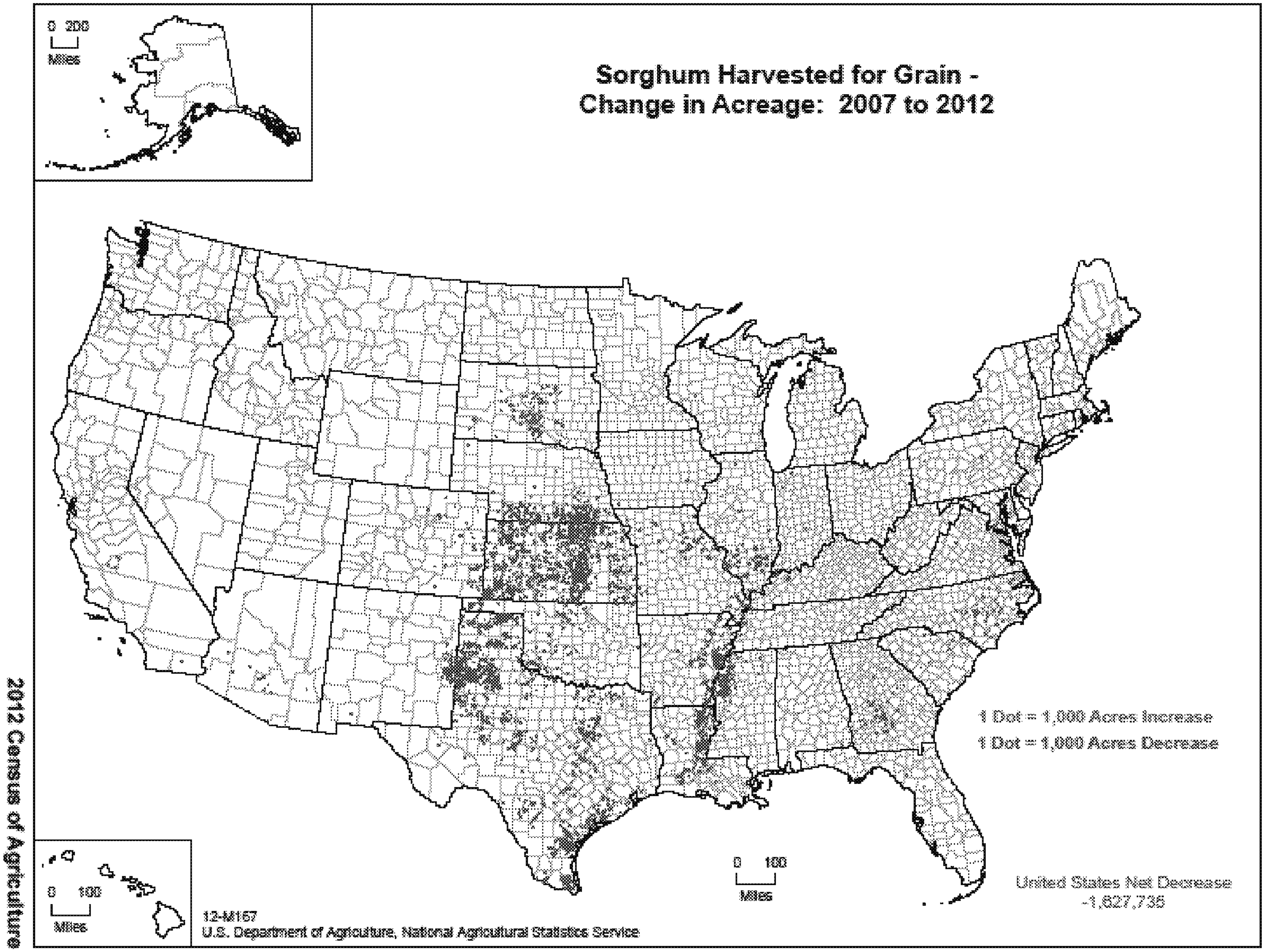


Figure 14. Rice, Harvested Acres, 2012, US Map

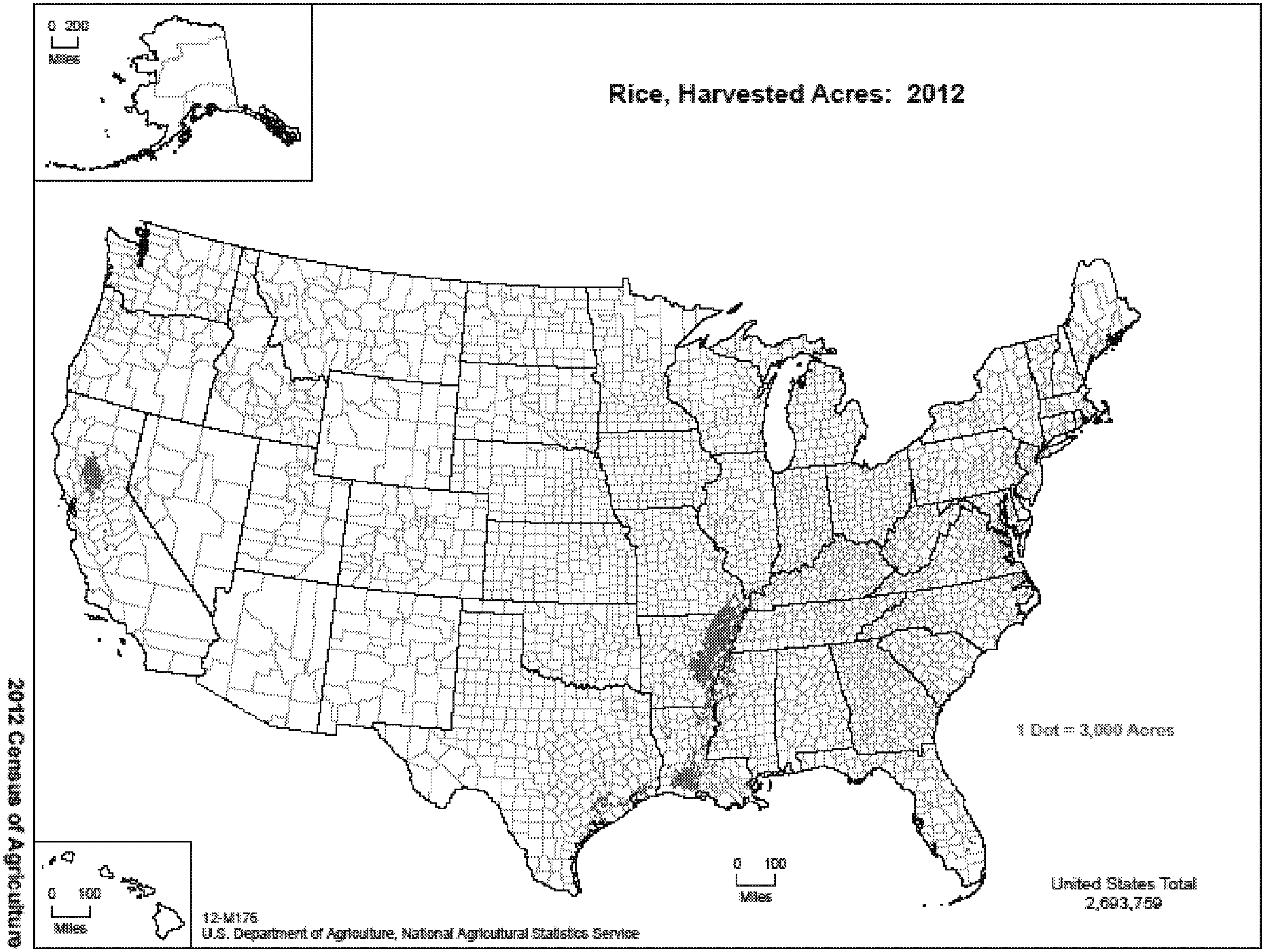
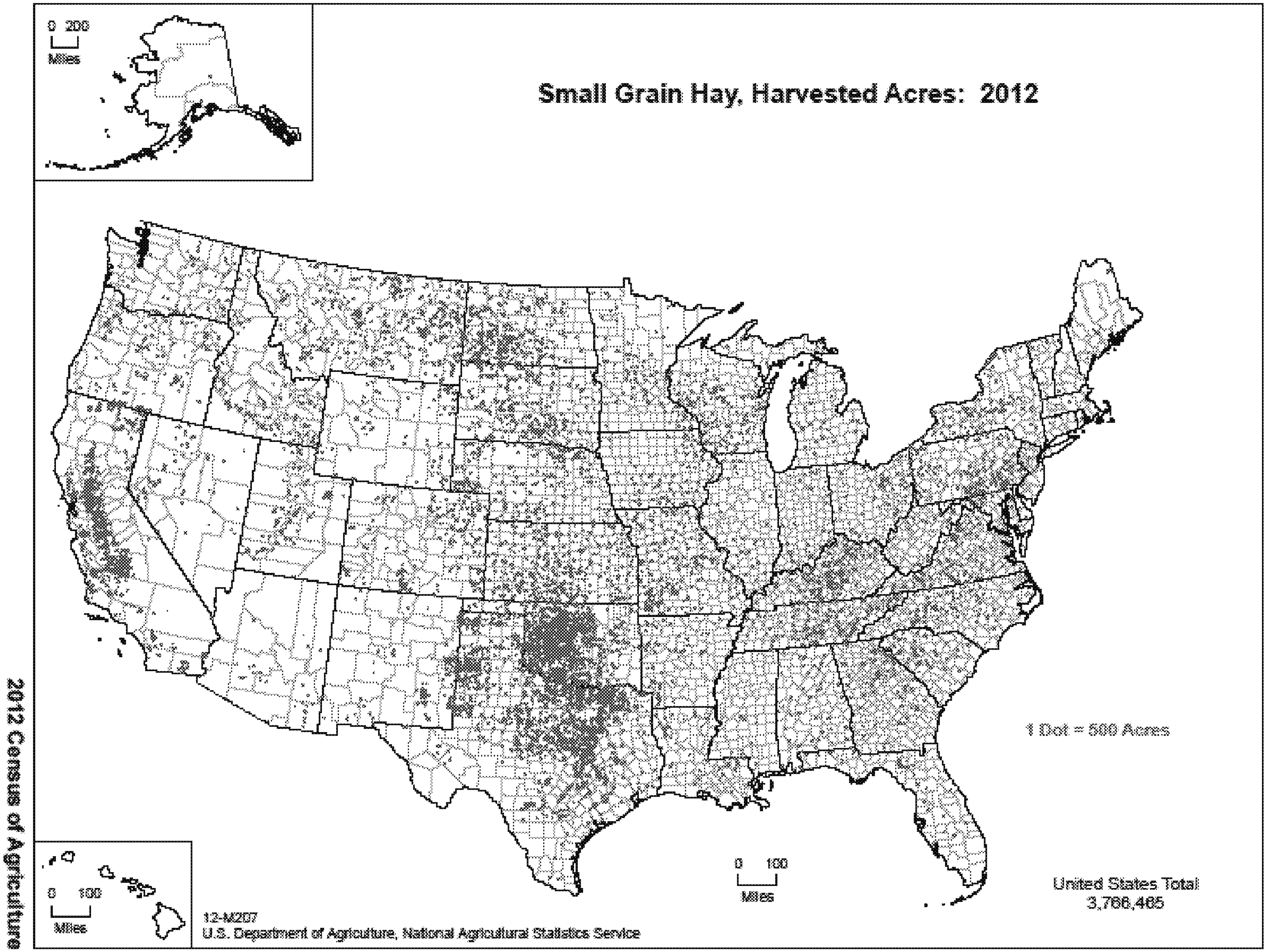


Figure 15. Small Grain Hay, Harvested Acres, 2012, US Map



APPENDIX:

Tolerances for Cereal Grain Group 15:

Table 16. Tolerances established on Cereal Grain Crop Group15:
(Data from mrldatabase.com; tolerances as of December 1, 2016; note that shading indicates a crop definition, group or subgroup tolerance); MRLs in parentheses are more restrictive than the US MRL.

	Barley, grain (ppm)			Buckwheat, grain (ppm)			Corn, grain (ppm)		
Compound	US	Codex	EU	US	Codex	EU	US	Codex	EU
2,4-D	2	-	0.05	-	-	0.05	0.05	0.05	0.05
Abamectin	0.01	-	0.01	0.01	-	0.01	0.01	-	0.01
Acephate	0.02	-	0.01	0.02	-	0.01	0.02	-	0.01
Acetamiprid	0.01	-	0.01	0.01	-	0.01	0.01	-	0.01
Acetochlor	-	-	-	-	-	-	0.05	0.02	0.01
Alachlor	-	-	-	-	-	-	0.2	-	0.01
Alpha-Cypermethrin	-	-	-	-	-	-	0.05	0.3	0.3
Ametryn	-	-	-	-	-	-	0.05	-	-
Amicarbazone	-	-	-	-	-	-	0.05	-	-
Aminopyralid	-	0.1	0.1	-	-	0.01	0.2	-	0.01
Atrazine	-	-	-	-	-	-	0.2	-	0.05
Azoxystrobin	3	1.5	1.5	-	-	0.01	0.05	0.02	0.02
Benoxacor	-	-	-	-	-	-	0.01	-	-
Bentazon	-	-	-	-	-	-	0.05	0.01	0.2
Benzovindiflupyr	1.5	-	0.5	-	-	0.01	0.02	-	0.01
Beta-cyfluthrin	0.15	-	0.3	0.15	-	0.02	0.05	-	0.05
Bicyclopyrone	-	-	-	-	-	-	0.02	-	-
Bifenthrin	0.05	0.05	0.5	0.05	-	0.05	0.05	0.05	0.05
Boscalid	-	0.5	4	-	0.1	0.15	-	0.1	0.15
Bromoxynil	0.05	-	0.05	-	-	0.01	0.05	-	0.1
Captan	0.05	-	0.07	0.05	-	0.07	0.05	-	0.07
Carbaryl	-	-	0.5	-	-	0.5	0.02	0.02	0.5
Carboxin	0.2	-	0.01	-	-	-	0.2	-	0.01
Carfentrazone-ethyl	0.1	-	0.05	0.1	-	0.05	0.1	-	0.05
Chlorantraniliprole	6	0.02	0.02	6	0.02	0.02	0.04	0.02	0.02
Chlorethoxyphos	-	-	-	-	-	-	0.01	-	-
Chlorfenapyr	0.01	-	0.02	0.01	-	0.02	0.01	-	0.02
Chlorimuron-ethyl	-	-	-	-	-	-	0.01	-	-
Chlorpyrifos	0.1	-	0.02	0.1	-	0.05	0.05	0.05	0.05
Clethodim	-	-	-	-	-	-	0.2	-	0.1
Chlorpyrifos-methyl	6	-	3	-	-	-	-	-	-
Chlorsulfuron	0.1	-	0.1	-	-	-	-	-	-
Clopyralid	3	-	2	-	-	-	1	-	2
Cloquintocet-mexyl	0.1	-	-	-	-	-	-	-	-
Clothianidin	0.01	0.04	0.04	0.01	-	0.01	0.01	0.02	0.02
Cyfluthrin	0.15	-	0.3	0.15	-	0.02	0.05	-	0.05
Cyproconazole	-	0.08	0.1	-	0.08	0.1	0.01	0.01	0.1
Cyprosulfamide	-	-	-	-	-	-	0.01	-	-
d-Phenothrin	0.01	-	0.05	0.01	-	0.05	0.01	-	0.05
Deltamethrin	1	2	2	1	2	2	1	2	2
Dicamba	6	7	7	-	-	0.3	0.1	0.01	0.5

Table 16. Tolerances established on Cereal Grains (continued)
(Data from mrldatabase.com; tolerances as of December 1, 2016; note that shading indicates a crop definition, group or subgroup tolerance); MRLs in parentheses are more restrictive than the US MRL.

	Barley, grain (ppm)			Buckwheat, grain (ppm)			Corn, grain (ppm)		
Dichlormid	-	-	-	-	-	-	0.05	-	-
Dichlorvos	-	-	0.01	-	-	0.01	-	-	0.01
Diclofop-Methyl	0.1	-	0.05	-	-	-	-	-	-
Difenoconazole	0.1	-	0.05	-	-	0.05	-	-	0.05
Diflubenzuron	0.06	0.05	0.1	-	-	0.05	-	-	0.05
Diflufenzopyr	-	-	-	-	-	-	0.05	-	-
Dimethenamid	-	-	-	-	-	-	0.01	0.01	0.01
Dimethenamid-P	-	-	-	-	-	-	0.01	0.01	0.01
Dimethoate	-	-	-	-	-	-	0.1	-	0.02
Dinotefuran	0.01	-	-	-	-	-	0.1	-	-
Diquat dibromide	0.02	5	10	0.02	-	0.05	0.02	0.05	1
Diuron	0.2	-	0.01	-	-	0.01	0.1	-	0.01
EPTC							0.08	-	0.01
Esfenvalerate	0.05	-	0.2	0.05	-	0.2	0.02	-	0.02
Ethephon	2	1.5	1	-	-	-	-	-	-
Ethoprop	-	-	-	-	-	-	0.02	-	0.02
Etofenprox	5	-	0.5	5	-	0.5	5	0.05	0.5
Etoxazole	-	-	-	-	-	-	0.01	-	0.02
Etridiazole	0.1	-	0.05	-	-	-	0.1	-	0.05
Fenbuconazole	-	0.2	0.2	-	-	0.05	-	-	0.05
Fenpyroximate	-	-	0.05	-	-	0.05	0.02	-	0.05
Fipronil	-	-	-	-	-	-	0.02	0.01	0.005
Fenoxaprop-Ethyl	0.05	-	-	-	-	-	-	-	-
Fenpropathrin	0.04	-	0.01	-	-	-	-	-	-
Florasulam	0.01	-	0.01	-	-	-	-	-	-
Flubendiamide	-	-	0.01	-	-	0.01	0.03	0.02	0.02
Fludioxonil	0.02	0.05	0.01	0.02	0.05	0.01	0.02	0.05	0.01
Flufenacet	-	-	-	-	-	-	0.05	-	0.05
Flufenpyr-ethyl	-	-	-	-	-	-	0.01	-	-
Flumetsulam	-	-	-	-	-	-	0.05	-	-
Flumiclorac-pentyl	-	-	-	-	-	-	0.01	-	-
Flumioxazin	-	-	0.02	-	-	0.02	0.02	0.02	0.02
Fluopyram	4	-	0.1	4	-	0.1	0.02	-	0.02
Fluoride	15	-	2	-	-	2	10	-	2
Fluoxastrobin	-	-	0.5	-	-	0.05	0.02	-	0.05
Flupyradifurone	-	-	-	3	-	0.01	0.05	-	0.01
Fluroxypyr	0.5	-	0.1	-	-	0.01	0.02	-	0.05
Fluthiacet-methyl	-	-	-	-	-	-	0.01	-	-
Flutriafol	-	-	0.15	-	-	0.01	0.01	0.01	0.01
Fluxapyroxad	3	2	2	3	-	0.01	0.01	0.01	0.01
Furilazole	3	-	0.01	-	-	-	0.01	-	-
Gamma Cyhalothrin	0.01	0.5	-	0.01	-	-	0.05	0.02	-
Glufosinate-ammonium	-	-	0.1	-	-	0.1	0.2	0.1	0.5
Glyphosate	30	30	20	30	30	0.1	5	5	1

Table 16. Tolerances established on Cereal Grains (continued)

(Data from mrldatabase.com; tolerances as of December 1, 2016; note that shading indicates a crop definition, group or subgroup tolerance); MRLs in parentheses are more restrictive than the US MRL.

	Barley, grain (ppm)			Buckwheat, grain (ppm)			Corn, grain (ppm)		
Halosulfuron-methyl	-	-	-	-	-	-	0.05	-	0.01
Hexythiazox	-	-	0.2	-	-	0.5	0.02	0.02	0.5
Hydroprene	0.2	-	-	0.2	-	-	0.2	-	-
Imazalil	0.1	-	0.05	-	-	-	-	-	-
Imazapyr	-	-	-	-	-	-	0.05	0.05	0.05
Imazethapyr	-	-	-	-	-	-	0.1	-	-
Imazamethabenz	0.1	-	-	-	-	-	-	-	-
Imidacloprid	0.05	0.05	0.1	0.05	0.05	0.1	0.05	0.05	0.1
Indoxacarb	-	-	0.01	-	-	0.01	-	-	0.01
Inorganic bromide resulting from fumigation with methyl bromide	50	50	50	-	50	50	50	50	50
Iodosulfuron-methyl	-	-	-	-	-	-	0.03	-	0.01
Ipconazole	0.1	-	0.1	0.1	-	0.1	0.1	-	0.1
Isoxadifen-ethyl	-	-	-	-	-	-	0.08	-	-
Isoxaflutole	-	-	0.02	-	-	0.02	0.02	0.02	0.02
Lambda Cyhalothrin	0.05	0.5	0.5	0.05	-	0.02	0.05	0.02	0.02
Linuron	-	-	-	-	-	-	0.1	-	0.05
Malathion	8	-	8	-	-	-	8	0.05	8
Mancozeb	1	1	2	-	-	-	0.06	-	0.05
MCPA	1	0.2	0.2	-	-	0.05	-	0.01	0.05
Mefenpyr-diethyl	0.05	-	-	-	-	-	-	-	-
Mesotrione	-	-	-	-	-	-	0.01	0.01	0.01
Mesosulfuron-methyl	-	-	-	-	-	-	-	-	0.01
Metalaxyl	0.1	0.05	0.05	0.1	0.05	0.05	0.1	0.05	0.05
Metalaxyl-M (Mefenoxam)	0.1	0.05	0.05	0.1	0.05	0.05	0.1	0.05	0.05
Metaldehyde	-	-	-	-	-	-	0.05	-	0.05
Metconazole	2.5	-	0.4	-	-	0.02	0.02	-	0.1
Methomyl	1	2	0.02	-	-	-	0.1	0.02	0.02
Methoxyfenozide	-	-	0.01	-	-	0.01	0.05	0.02	0.02
Metolachlor	-	-	-	-	-	-	0.1	-	0.05
Metribuzin	0.75	-	0.1	-	-	-	0.05	-	0.1
Metsulfuron-methyl	0.1	-	0.01	-	-	0.01	-	-	-
MGK 264	5	-	-	5	-	-	5	-	-
Myclobutanil	-	-	0.02	-	-	0.02	-	-	0.02
Naled	0.5	-	-	0.5	-	-	0.5	-	-
Nicosulfuron	-	-	-	-	-	-	0.1	-	0.01
Nitrapyrin	-	-	-	-	-	-	0.1	-	-
Novaluron	0.01	-	0.01	0.01	-	0.01	0.01	-	0.01
Oxyfluorfen	-	-	-	-	-	-	0.05	-	0.05
Paraquat dichloride	0.05	-	0.02	-	-	0.02	0.1	0.03	0.02
Pendimethalin	-	-	-	-	-	-	0.1	-	0.05

Table 16. Tolerances established on Cereal Grains (continued)

(Data from mrldatabase.com; tolerances as of December 1, 2016; note that shading indicates a crop definition, group or subgroup tolerance); MRLs in parentheses are more restrictive than the US MRL.

	Barley, grain (ppm)			Buckwheat, grain (ppm)			Corn, grain (ppm)		
Penflufen	0.01	-	-	0.01	-	0.01	0.01	-	-
Penthiopyrad	0.15	0.2	0.2	0.15	-	0.01	0.01	0.01	0.01
Permethrin	-	2	0.05	-	2	0.05	0.05	2	0.05
Phorate	-	-	-	-	-	-	0.05	0.05	0.05
Phosphine	0.1	0.1	0.1	0.01	0.1	0.1	0.01	0.01	0.01
Picloram	0.5	-	0.2	-	-	0.01	-	-	0.2
Picoxystrobin	0.3	-	0.3	0.04	-	0.05	0.04	0.01	0.05
Pinoxaden	0.9	-	1	0.04	-	0.01	-	-	-
Piperonyl Butoxide	20	30	-	20	30	-	20	30	-
Pirimiphos-methyl	-	7	5	-	7	0.5	8	7	0.5
Prallethrin	1	-	-	1	-	-	1	-	-
Primisulfuron-methyl	-	-	-	-	-	-	0.02	-	-
Propachlor	-	-	-	-	-	-	0.2	-	0.02
Propargite	-	-	0.01	-	-	0.01	0.01	0.1	0.1
Propetamphos	0.1	-	-	0.1	-	-	0.1	-	-
Propiconazole	3	2	0.3	-	-	0.01	0.2	0.05	0.05
Prosulfuron	0.01	-	0.01	0.01	-	0.01	0.01	-	0.01
Prothioconazole	0.35	0.2	0.2	0.35	-	0.01	0.35	0.1	0.1
Pyraclostrobin	1.4	1	1	-	-	0.02	0.1	0.02	0.02
Pyraflufen-ethyl	-	-	-	-	-	-	0.01	-	0.02
Pyrasulfotole	0.02	-	0.02	-	-	0.02	-	-	0.02
Pyrethrins	3	0.3	3	3	0.3	3	3	0.3	3
Pyridate	-	-	-	-	-	-	0.03	-	0.05
Pyriproxyfen	1.1	-	0.05	1.1	-	0.05	1.1	-	0.05
Pyroxsulfone	-	-	-	-	-	-	0.02	-	-
Quinclorac	2	-	0.01	-	-	0.01	-	-	0.01
Quizalofop-ethyl	0.05	-	0.05	-	-	0.05	-	-	0.05
Resmethrin	3	-	0.05	3	-	0.05	3	-	0.05
Rimsulfuron	-	-	0.01	-	-	0.01	0.1	-	0.01
S-metolachor	-	-	0.05	-	-	0.05	0.1	-	0.05
Saflufenacil	1	0.01	0.03	0.03	0.01	0.03	0.03	0.01	0.03
Sedaxane	0.01	0.01	0.01	-	-	-	0.01	0.01	0.01
Sethoxydim	-	-	-	19	-	0.1	0.5	-	0.1
Simazine	-	-	-	-	-	-	0.2	-	0.01
Spinetoram	0.04	-	0.05	0.04	-	0.05	0.04	-	0.05
Spinosad	1.5	1	2	1.5	1	2	1.5	1	2
Spiromesifen	-	-	-	-	-	-	0.02	-	0.02
Spirotetramat	-	-	0.1	-	-	0.1	-	-	0.1
Sulfentrazone	-	-	-	-	-	-	0.15	-	-
Sulfoxaflor	0.4	0.6	0.04	-	-	0.01	-	-	0.01
Sulfuryl fluoride	0.1	0.05	0.05	-	0.05	0.05	0.05	0.05	0.05

Table 16. Tolerances established on Cereal Grains (continued)

(Data from mrldatabase.com; tolerances as of December 1, 2016; note that shading indicates a crop definition, group or subgroup tolerance); MRLs in parentheses are more restrictive than the US MRL.

	Barley, grain (ppm)			Buckwheat, grain (ppm)			Corn, grain (ppm)		
TCMTB	0.1	-	-	-	-	-	0.1	-	-
Tebuconazole	0.3	2	2	-	-	0.02	0.05	-	0.02
Teflubenzuron	-	-	-	-	-	-	0.01	-	0.01
Tefluthrin	-	-	-	-	-	-	0.06	-	0.05
Tembotrione	-	-	-	-	-	-	0.02	-	0.02
Tepraloxydim	-	-	0.01	-	-	0.1	-	-	0.1
Terbufos	-	-	-	-	-	-	0.5	0.01	0.01
Tetraconazole	-	-	0.01	-	-	0.05	0.01	-	0.05
Thiabendazole	0.05	-	0.05	-	-	-	0.01	-	0.05
Thiamethoxam	0.4	0.4	0.4	0.02	-	0.01	0.02	0.05	0.05
Thiencarbazone-methyl	-	-	-	-	-	-	0.01	-	-
Thifensulfuron-methyl	0.05	-	0.01	-	-	-	0.05	-	0.01
Thiophanate-methyl	-	0.5	0.3	-	-	0.01	-	-	0.01
Topramezone	-	-	-	-	-	-	0.01	-	0.01
Tralkoxydim	0.02	-	0.02	-	-	-	-	-	-
Tri-Allate	0.05	-	0.1	-	-	-	-	-	-
Triadimenol	0.05	0.2	0.2	-	-	-	0.05	0.2	0.1
Triasulfuron	0.02	-	0.05	-	-	-	-	-	-
Tribenuron Methyl	0.05	-	0.01	-	-	0.01	0.01	-	0.01
Trifloxystrobin	0.05	0.5	0.5	-	-	0.01	0.05	0.02	0.02
Trifluralin	0.05	-	0.01	-	-	-	0.05	-	0.01
Trinexapac-ethyl	2	3	3	-	-	-	-	-	-
Triticonazole	0.01	-	0.01	0.01	-	0.01	0.01	-	0.01
Zeta-Cypermethrin	3	2	2	3	0.3	0.3	0.05	0.3	0.3
Zinc phosphide	0.05	0.1	0.1	-	0.3	0.3	-	-	-

Table 16. Tolerances established on Cereal Grains (continued)

(Data from mrldatabase.com; tolerances as of December 1, 2016; note that shading indicates a crop definition, group or subgroup tolerance); MRLs in parentheses are more restrictive than the US MRL.

	Corn, pop (ppm)			Corn, sweet (ppm)			Millet, pearl, grain (ppm)		
Compound	US	Codex	EU	US	Codex	EU	US	Codex	EU
2,4-D	0.05	-	0.05	0.05	0.05	0.05	2	-	0.05
Abamectin	0.01	-	0.01	0.01	-	0.01	0.01	-	0.01
Acephate	0.02	-	0.01	0.02	-	0.01	0.02	-	0.01
Acetamiprid	0.01	-	0.01	0.01	0.01	0.01	0.01	-	0.01
Acetochlor	0.05	-	0.01	0.05	0.04	0.1	-	-	-
Alachlor	0.2	-	0.01	0.05	-	0.01	-	-	-
Alpha-Cypermethrin	0.05	0.3	0.3	0.05	0.05	0.05	-	-	-
Ametryn	0.05	-	-	-	-	-	-	-	-
Aminopyralid	-	-	0.01	-	-	0.01	-	-	0.01
Atrazine	0.2	-	0.05	0.2	-	0.05	-	-	-
Azoxystrobin	0.05	-	0.01	0.05	3	0.01	-	-	0.01
Benoxacor	0.01	-	-	0.01	-	-	-	-	-
Bentazon	0.05	0.01	0.3	0.05	0.01	0.3	-	-	-
Benzovindiflupyr	0.02	-	0.01	0.01	-	0.01	-	-	0.01
Beta-cyfluthrin	0.05	-	0.02	0.05	-	0.02	0.15	-	0.02
Bicyclopyrone	0.02	-	-	0.03	-	-	-	-	-
Bifenthrin	0.05	-	0.05	0.05	-	0.05	0.05	-	0.05
Boscalid	-	0.1	0.15	-	0.1	0.05	-	0.1	0.15
Bromoxynil	0.05	-	0.01	-	-	0.04	-	-	0.1
Captan	0.05	-	0.07	0.05	-	0.03	0.05	-	0.07
Carbaryl	0.02	-	0.5	0.1	0.1	0.01	-	-	0.5
Carboxin	0.2	-	0.01	0.2	-	0.1	-	-	-
Carfentrazone-ethyl	0.1	-	0.05	0.1	-	0.01	0.1	-	0.05
Chlorantraniliprole	0.04	0.02	0.02	0.02	0.01	0.2	6	0.02	0.02
Chlorethoxyphos	0.01	-	-	0.01	-	-	-	-	-
Chlorfenapyr	0.01	-	0.02	0.01	-	0.01	0.01	-	0.02
Chlorothalonil	-	-	-	1	-	0.01	-	-	-
Chlorimuron-ethyl	-	-	-	-	-	-	-	-	-
Chlorpyrifos	0.1	-	0.05	0.05	0.01	0.05	0.1	-	0.05
Clopyralid	1	0.01	2	1	-	0.5	-	-	-
Cloquintocet-mexyl	-	-	-	-	-	-	-	-	-
Clothianidin	0.01	0.01	0.01	0.01	0.01	0.01	0.01	-	0.01
Cyfluthrin	0.05	-	0.02	0.05	-	0.02	0.15	-	0.02
Cyproconazole	-	0.08	0.1	-	0.08	0.05	-	0.08	0.1
Cyprosulfamide	0.01	-	-	0.01	-	-	-	-	-
d-Phenothrin	0.01	-	0.05	0.01	-	0.05	0.01	-	0.05
Deltamethrin	1	2	2	0.03	0.02	0.05	1	2	2
Dicamba	0.1	-	0.3	0.04	0.02	0.07	-	-	0.3

Table 16. Tolerances established on Cereal Grains (continued)

(Data from mrldatabase.com; tolerances as of December 1, 2016; note that shading indicates a crop definition, group or subgroup tolerance); MRLs in parentheses are more restrictive than the US MRL.

	Corn, pop (ppm)			Corn, sweet (ppm)			Millet, pearl, grain (ppm)		
Dichlormid	0.05	-	-	0.05	-	-	-	-	-
Dichlorvos	-	-	0.01	-	-	0.01	-	-	0.01
Difenoconazole	-	-	0.05	0.01	-	0.05	-	-	0.05
Diflubenzuron	-	-	0.05	-	-	0.05	-	-	0.05
Diflufenzopyr	0.05	-	-	0.05	-	-	-	-	-
Dimethenamid	0.01	-	0.01	0.01	0.01	0.01	-	-	-
Dimethenamid-P	0.01	-	0.01	0.01	0.01	0.01	-	-	-
Dimethoate	0.1	-	0.02	-	-	-	-	-	-
Dinotefuran	0.01	-	-	0.01	-	-	0.01	-	-
Diquat dibromide	0.02	-	0.05	0.02	0.05	0.05	0.02	0.05	1
Diuron	0.1	-	0.01	-	-	0.01	-	-	0.01
Endosulfan	-	-	-	0.2	-	0.05	-	-	-
EPTC	0.08	-	0.01	0.08	-	0.01	-	-	-
Esfenvalerate	0.02	-	0.02	0.1	-	0.02	0.05	-	0.02
Ethoprop	-	-	-	0.02	-	0.02	-	-	-
Etofenprox	5	-	0.5	5	-	0.05	5	-	0.5
Etoxazole	0.01	-	0.02	-	-	-	-	-	-
Etridiazole	-	-	-	-	-	-	-	-	-
Fenbuconazole	-	-	0.05	-	-	0.05	-	-	0.05
Fenpyroximate	0.02	-	0.05	-	-	0.05	-	-	0.05
Flubendiamide	0.02	-	0.01	0.01	0.02	0.02	-	-	0.01
Fludioxonil	0.02	0.05	0.01	0.02	0.01	0.01	0.02	0.05	0.01
Flufenacet	-	-	-	0.05	-	0.05	-	-	-
Flumioxazin	-	-	0.02	-	-	0.02	-	-	0.02
Fluopyram	0.02	-	0.1	0.01	-	0.1	4	-	0.1
Fluoride	10	-	2	-	-	2	40	-	2
Fluoxastrobin	-	-	0.05	0.01	-	0.05	-	-	0.05
Flupyradifurone	0.05	-	0.01	0.05	-	0.01	3	-	0.01
Fluroxypyr	-	-	0.01	0.02	-	0.01	0.5	-	0.01
Fluthiacet-methyl	0.01	-	-	0.01	-	-	-	-	-
Flutriafol	0.01	-	0.01	-	-	0.01	-	-	0.01
Fluxapyroxad	0.01	-	0.01	0.15	0.15	0.15	3	-	0.01
Furilazole	0.01	-	-	-	-	-	-	-	-
Gamma Cyhalothrin	0.05	-	-	0.05	0.3	-	0.01	-	-
Glufosinate-ammonium	-	-	0.1	0.3	-	0.1	-	-	0.1
Glyphosate	0.1	30	0.1	3.5	3	3	30	30	0.1

Table 16. Tolerances established on Cereal Grains (continued)

(Data from mrldatabase.com; tolerances as of December 1, 2016; note that shading indicates a crop definition, group or subgroup tolerance); MRLs in parentheses are more restrictive than the US MRL.

	Corn, pop (ppm)			Corn, sweet (ppm)			Millet, pearl, grain (ppm)		
Halosulfuron-methyl	0.05	-	0.01	0.05	-	0.01	-	-	0.5
Hexythiazox	-	-	0.05	0.1	-	0.5	-	-	0.5
Hydroprene	0.2	-	-	0.2	-	-	0.2	-	-
Imidacloprid	0.05	0.05	0.05	0.05	0.02	0.1	0.05	0.05	0.05
Indoxacarb	-	-	0.01	0.02	0.02	0.02	-	-	0.01
Inorganic bromide resulting from fumigation with methyl bromide	240	50	50	50	50	30	-	50	50
Ipconazole	0.01	-	0.01	0.01	-	0.01	0.01	-	0.01
Isoxadifen-ethyl	0.04	-	-	0.04	-	-	-	-	-
Isoxaflutole	-	-	0.02	-	0.02	0.02	-	-	0.02
Lambda Cyhalothrin	0.05	-	0.02	0.05	0.3	0.05	0.01	-	0.02
Linuron	-	-	-	0.25	-	0.05	-	-	-
Malathion	8	-	8	2	0.02	0.02	-	-	-
Mancozeb	0.1	-	0.05	0.1	0.1	0.05	-	-	-
MCPA	-	-	0.05	-	-	0.05	-	-	0.05
Mefenpyr-diethyl	-	-	-	-	-	-	-	-	-
Mesosulfuron-methyl	-	-	0.01	-	-	0.01	-	-	0.01
Mesotrione	0.01	-	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Metalaxyl	0.1	0.05	0.05	0.1	0.05	0.05	0.1	0.05	0.05
Metalaxyl-M (Mefenoxam)	0.1	0.05	0.05	0.1	0.05	0.05	0.1	0.05	0.05
Metaldehyde	-	-	-	0.05	-	0.05	-	-	-
Metconazole	0.02	-	0.02	0.01	-	0.02	-	-	0.02
Methomyl	0.1	-	0.02	0.1	-	0.02	-	-	-
Methoxyfenozide	0.05	-	0.01	0.05	0.02	0.02	-	-	0.01
Metolachlor	0.1	-	0.05	0.1	-	0.05	-	-	-
Metribuzin	0.05	-	0.1	0.05	-	0.1	-	-	-
MGK 264	5	-	-	5	-	-	5	-	-
Myclobutanil	-	-	0.02	-	-	0.02	-	-	0.02
Naled	0.5	-	-	0.5	-	-	0.5	-	-
Nicosulfuron	0.1	-	0.01	0.1	-	0.01	-	-	-
Nitrapyrin	0.1	-	-	0.1	-	-	-	-	-
Novaluron	0.01	-	0.01	0.05	-	0.01	0.01	-	0.01
Oxydemeton-methyl	-	-	-	0.5	-	0.01	-	-	-
Paraquat dichloride	0.1	-	0.02	0.05	0.05	0.02	-	-	0.02
Pendimethalin	0.1	-	0.05	0.1	-	0.05	-	-	-
Penflufen	0.01	-	-	0.01	-	-	0.01	-	-
Penthiopyrad	0.01	-	0.01	0.01	0.02	0.01	0.8	0.8	0.8

Table 16. Tolerances established on Cereal Grains (continued)

(Data from mrldatabase.com; tolerances as of December 1, 2016; note that shading indicates a crop definition, group or subgroup tolerance); MRLs in parentheses are more restrictive than the US MRL.

	Corn, pop (ppm)			Corn, sweet (ppm)			Millet, pearl, grain (ppm)		
Permethrin	0.05	2	0.05	0.1	0.1	0.05	-	2	0.05
Phorate	-	-	-	0.05	-	0.01	-	-	-
Phosphine	0.1	0.1	0.1	0.01	0.1	0.05	0.1	0.1	0.1
Picloram	-	-	0.2	-	-	0.01	-	-	0.01
Picoxystrobin	0.04	-	0.01	0.04	-	0.01	0.04	-	0.01
Piperonyl Butoxide	20	30	-	10	-	-	10	30	-
Pirimiphos-methyl	8	7	0.5	-	7	0.01	-	7	5
Prallethrin	1	-	-	1	-	-	1	-	-
Primisulfuron-methyl	0.02	-	-	-	-	-	-	-	-
Propargite	0.1	-	0.01	0.1	-	0.01	-	-	0.01
Propetamphos	0.1	-	-	0.1	-	-	0.1	-	-
Propiconazole	0.2	0.05	0.01	0.1	0.05	0.05	-	-	0.01
Prosulfuron	0.01	-	0.01	0.01	-	0.01	0.01	-	0.01
Prothioconazole	0.35	0.1	0.01	0.04	0.02	0.02	0.35	-	0.01
Pyraclostrobin	0.1	-	0.02	0.04	-	0.02	-	-	0.02
Pyrasulfotole	-	-	0.02	-	-	0.01	-	-	0.02
Pyrethrins	3	0.3	3	1	-	1	1	0.3	3
Pyridate	0.3	-	0.05	-	-	-	-	-	-
Pyriproxyfen	1.1	-	0.05	1.1	-	0.05	1.1	-	0.05
Pyroxsulfone	0.015	-	-	0.015	-	-	-	-	-
Quinclorac	-	-	0.01	-	-	0.01	-	-	0.01
Quizalofop-ethyl	-	-	0.05	-	-	0.4	-	-	0.05
Resmethrin	3	-	0.05	3	-	0.1	3	-	0.05
Rimsulfuron	-	-	0.01	-	-	0.01	-	-	0.01
S-metolachor	0.1	-	0.05	0.1	-	0.05	-	-	-
Saflufenacil	0.03	0.01	0.03	0.03	0.01	0.03	0.03	0.01	0.03
Sedaxane	0.01	0.01	0.01	0.01	0.01	0.01	-	-	-
Sethoxydim	-	-	-	0.4	-	0.5	-	-	-
Simazine	0.2	-	0.01	0.25	-	0.01	-	-	-
S-metolachlor	-	-	-	0.1	-	0.05	-	-	0.05
Spinetoram	0.04	-	0.05	0.04	-	0.05	1	-	0.05
Spinosad	1.5	1	2	0.02	0.01	0.02	1.5	1	2
Spiromesifen	0.02	-	0.02	0.02	-	0.02	-	-	-
Spirotetramat	-	-	0.1	1.5	1.5	0.1	-	-	0.1
Sulfoxaflor	-	-	0.01	-	-	0.01	-	-	0.01
Sulfuryl fluoride	0.05	0.05	0.05	-	0.05	0.01	0.1	0.05	0.05

Table 16. Tolerances established on Cereal Grains (continued)

(Data from mrldatabase.com; tolerances as of December 1, 2016; note that shading indicates a crop definition, group or subgroup tolerance); MRLs in parentheses are more restrictive than the US MRL.

	Corn, pop (ppm)			Corn, sweet (ppm)			Millet, pearl, grain (ppm)		
TCMTB	0.1	-	-	-	-	-	-	-	-
Tebuconazole	0.05	-	0.02	0.5	0.6	0.6	-	-	0.02
Tefluthrin	0.06	-	0.05	0.06	-	0.05	-	-	-
Tembotrione	0.02	-	0.02	0.01	-	0.05	-	-	-
Tepraloxydim	-	-	0.1	-	-	0.1	-	-	0.1
Terbufos	0.5	-	0.01	0.05	0.01	0.01	-	-	-
Tetraconazole	0.01	-	0.05	-	-	0.02	-	-	0.05
Thiabendazole	0.01	-	0.05	0.01	-	0.05	-	-	-
Thiamethoxam	0.02	0.01	0.01	0.02	0.01	0.02	0.02	-	0.01
Thiencarbazone-methyl	0.01	-	-	0.01	-	-	-	-	-
Thifensulfuron-methyl	0.01	-	-	-	-	-	-	-	-
Thiodicarb	-	-	-	2	-	0.02	-	-	-
Thiophanate-methyl	-	-	0.01	-	-	0.1	-	-	0.01
Topramezone	0.01	-	0.01	0.01	-	0.01	-	-	-
Triadimenol	0.05	0.2	0.1	0.05	0.2	0.1	-	-	-
Tribenuron Methyl	-	-	0.01	-	-	0.01	-	-	0.01
Trifloxystrobin	0.05	-	0.01	0.04	-	0.01	-	-	0.01
Triticonazole	0.01	-	0.01	0.01	-	0.01	0.01	-	0.01
Zeta-Cypermethrin	0.05	0.3	0.3	0.05	0.05	0.05	0.05	0.3	0.3

Table 16. Tolerances established on Cereal Grains (continued)
(Data from mrldatabase.com; tolerances as of December 1, 2016; note that shading indicates a crop definition, group or subgroup tolerance); MRLs in parentheses are more restrictive than the US MRL.

	Millet, proso, grain (ppm)			Oat, grain (ppm)			Rice, grain (ppm)		
Compound	US	Codex	EU	US	Codex	EU	US	Codex	EU
2,4-D	2	-	0.05	2	-	0.05	0.5	0.1	0.1
Abamectin	0.01	-	0.01	0.01	-	0.01	0.01	0.002	0.01
Acephate	0.02	-	0.01	0.02	-	0.01	0.02	-	0.01
Acetamiprid	0.01	-	0.01	0.01	-	0.01	0.01	-	0.01
Acifluorten	-	-	-	-	-	-	0.1	-	-
Alpha-Cypermethrin	-	-	-	-	-	-	1.5	2	2
Aminopyralid	-	-	-	-	0.1	0.1	-	-	0.01
Azoxystrobin	-	-	0.01	1.5	1.5	1.5	5	5	5
Bensulfuron-methyl	-	-	-	-	-	-	0.02	-	-
Bentazon	-	-	-	-	-	-	0.05	0.01	0.1
Benzovindiflupyr	-	-	0.01	1.5	-	0.5	-	-	0.01
Beta-cyfluthrin	0.15	-	0.02	0.15	-	0.3	-	-	0.02
Bifenthrin	0.05	-	0.05	0.05	-	0.5	0.05	-	0.05
Bispyribac-sodium	-	-	-	-	-	-	0.02	-	-
Boscalid	-	0.1	0.15	-	0.5	4	-	0.1	0.15
Bromoxynil	-	-	0.1	0.05	-	0.05	-	-	0.01
Buprofezin	-	-	-	-	-	-	-	-	-
Captan	0.05	-	0.07	0.05	-	0.07	0.05	-	0.07
Carbaryl	1	-	0.5	-	-	0.5	15	1	0.01
Carbofuran	-	-	-	-	-	-	0.2	0.1	0.01
Carboxin	-	-	-	0.2	-	0.01	0.2	-	0.01
Carfentrazone-ethyl	0.1	-	0.05	0.1	-	0.05	1.3	-	0.05
Chlorantraniliprole	6	0.02	0.02	6	0.02	0.02	0.15	0.4	0.4
Chlorfenapyr	0.01	-	0.02	0.01	-	0.02	0.01	-	0.02
Chlorpyrifos	0.1	-	0.05	0.1	-	0.05	0.1	0.5	0.05
Chlorpyrifos-methyl	-	-	-	6	-	3	6	0.1	3
Chlorsulfuron	-	-	-	0.1	-	0.1	-	-	-
Clomazone	-	-	-	-	-	-	0.02	-	0.01
Clopyralid	-	-	-	3	-	2	-	-	-
Clothianidin	0.01	-	0.01	0.01	-	0.02	0.01	0.5	0.5
Cyfluthrin	0.15	-	0.02	0.15	-	0.3	0.05	-	0.02
Cyhalofop-butyl	-	-	-	-	-	-	0.4	-	0.01
Cyproconazole	-	0.08	0.1	-	0.08	0.1	-	-	0.1
d-Phenothrin	0.01	-	0.05	0.01	-	0.05	0.01	-	0.05
Deltamethrin	1	2	2	1	2	2	1	2	2
Dicamba	2	-	0.3	2	-	0.5	-	-	0.3
Dichlorvos	-	-	0.01	-	-	0.01	-	7	0.01
Difenoconazole	-	-	0.05	0.01	-	0.05	-	-	3
Diflubenzuron	-	-	0.05	0.06	0.05	0.1	0.02	0.01	0.05
Dinotefuran	0.01	-	-	0.01	-	-	9	8	8
Diquat dibromide	0.02	-	1	0.02	2	2	0.02	10	0.05
Diuron	-	-	0.01	0.1	-	0.01	-	-	0.01
Endothall	-	-	-	-	-	-	0.05	-	-
Esfenvalerate	0.05	-	0.02	0.05	-	0.2	0.05	-	0.2
Ethiprole	-	-	-	-	-	-	1.7	-	-
Etofenprox	5	-	0.5	5	-	0.5	0.01	0.01	0.5

Table 16. Tolerances established on Cereal Grains (continued)

(Data from mrldatabase.com; tolerances as of December 1, 2016; note that shading indicates a crop definition, group or subgroup tolerance); MRLs in parentheses are more restrictive than the US MRL.

	Millet, proso, grain (ppm)			Oat, grain (ppm)			Rice, grain (ppm)		
Fenbuconazole	-	-	0.05	-	-	0.05	-	-	0.05
Fenoxaprop-Ethyl	-	-	-	-	-	-	0.05	-	-
Fenpyroximate	-	-	0.05	-	-	0.05	-	-	0.05
Fipronil	-	-	-	-	-	-	0.04	0.01	0.005
Florasulam	-	-	-	0.01	-	0.01	-	-	-
Flubendiamide	-	-	0.01	-	-	0.01	0.5	-	0.2
Fludioxonil	0.02	0.05	0.01	0.02	0.05	0.01	0.02	0.05	0.01
Flumioxazin	-	-	0.02	-	-	0.02	-	-	0.02
Fluopyram	4	-	0.1	4	-	0.1	-	-	0.01
Fluoride	40	-	2	25	-	2	12	-	2
Fluoxastrobin	-	-	0.05	-	-	0.5	4	-	0.05
Flupyradifurone	3	-	0.01	3	-	0.01	-	-	0.01
Fluroxypyr	0.5	-	0.01	0.5	-	0.1	1.5	-	0.01
Flutolanil	-	-	-	-	-	-	7	2	2
Flutriafol	-	-	0.01	-	-	0.01	-	-	1.5
Fluxapyroxad	3	-	0.01	3	2	2	5	5	5
Gamma Cyhalothrin	0.01	-	-	0.01	0.05	-	1	1	-
Glufosinate-ammonium	-	-	0.1	-	-	0.1	1	0.9	0.9
Glyphosate	30	30	0.1	30	30	20	0.1	30	0.1
Halosulfuron-methyl	0.01	-	0.01	-	-	-	0.05	-	0.01
Hexythiazox	-	-	0.05	-	-	0.05	-	-	0.05
Hydroprene	0.2	-	-	0.2	-	-	0.2	-	-
Imazethapyr	-	-	-	-	-	-	0.3	-	-
Imazosulfuron	-	-	-	-	-	-	0.02	-	0.01
Imidacloprid	0.05	0.05	0.05	0.05	0.05	0.1	-	0.05	1.5
Indoxacarb	-	-	0.01	-	-	0.01	-	-	0.01
Inorganic bromide resulting from fumigation with methyl bromide	-	50	50	50	50	50	50	50	50
Ipconazole	0.01	-	0.01	0.01	-	0.01	-	-	-
Iprodione	-	-	-	-	-	-	10	10	10
Isoxadifen-ethyl	-	-	-	-	-	-	0.1	-	-
Isoxaflutole	-	-	0.02	-	-	0.02	-	-	0.02
Lambda Cyhalothrin	0.01	-	0.02	0.05	0.05	0.05	1	1	1
Malathion	-	-	-	8	-	8	8	-	8
Mancozeb	-	-	-	1	-	2	0.06	-	0.05
MCPA	-	-	0.05	1	0.2	0.2	-	-	0.05
Mesosulfuron-methyl	-	-	0.01	-	-	0.01	-	-	0.01
Mesotrione	0.01	0.01	0.01	0.01	0.01	0.01	-	-	-
Metalaxyl	0.1	0.05	0.05	0.1	0.05	0.05	0.1	0.05	0.05
Metalaxyl-M (Mefenoxam)	0.1	0.05	0.05	0.1	0.05	0.05	0.1	0.05	0.05
Metconazole	-	-	0.02	1	-	0.4	-	-	0.02
Methomyl	-	-	-	1	0.02	0.02	-	-	-

Table 16. Tolerances established on Cereal Grains (continued)

(Data from mrldatabase.com; tolerances as of December 1, 2016; note that shading indicates a crop definition, group or subgroup tolerance); MRLs in parentheses are more restrictive than the US MRL.

	Millet, proso, grain (ppm)			Oat, grain (ppm)			Rice, grain (ppm)		
Methoxyfenozide	-	-	0.01	-	-	0.01	0.5	-	0.01
MGK 264	5	-	-	5	-	-	5	-	-
Myclobutanil	-	-	0.02	-	-	0.02	-	-	0.02
Naled	0.5	-	-	0.5	-	-	0.5	-	-
Novaluron	0.01	-	0.01	0.01	-	0.01	0.01	-	0.01
Orthosulfamuron	-	-	-	-	-	-	0.05	-	0.03
Paraquat dichloride	-	-	0.02	-	-	0.02	0.05	0.05	0.05
Pendimethalin	-	-	-	-	-	-	0.1	-	0.05
Penflufen	0.01	-	-	0.01	-	-	0.01	-	-
Penthiopyrad	0.8	0.8	0.8	0.15	0.2	0.2	-	-	-
Penoxsulam	-	-	-	-	-	-	0.02	-	0.01
Penthiopyrad	-	-	-	-	-	-	-	-	0.01
Permethrin	-	2	0.05	-	2	0.05	-	2	0.05
Phosphine	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Picloram	-	-	0.01	0.5	-	0.2	-	-	0.01
Picoxystrobin	0.04	-	0.01	0.04	-	0.3	-	-	0.01
Piperonyl Butoxide	10	30	-	8	30	-	20	30	-
Pirimiphos-methyl	-	7	5	-	7	5	-	7	0.5
Prallethrin	1	-	-	1	-	-	1	-	-
Propanil	-	-	-	-	-	-	10	-	0.01
Propargite	-	-	0.01	-	-	0.01	-	-	0.01
Propetamphos	0.1	-	-	0.1	-	-	0.1	-	-
Propiconazole	-	-	0.01	3	0.7	0.3	7	-	1.5
Prosulfuron	0.01	-	0.01	0.01	-	0.01	-	-	-
Prothioconazole	0.35	-	0.01	0.35	0.05	0.05	0.35	-	0.01
Pyraclostrobin	-	-	0.02	1.2	1	1	-	-	0.02
Pyrasulfotole	-	-	0.02	0.08	0.3	0.2	-	-	0.02
Pyrethrins	1	0.3	3	1	0.3	3	3	0.3	3
Pyriproxyfen	1.1	-	0.05	1.1	-	0.05	1.1	-	0.05
Quinclorac	-	-	0.01	-	-	0.01	5	-	5
Quizalofop-ethyl	-	-	0.05	-	-	0.05	-	-	0.05
Resmethrin	3	-	0.05	3	-	0.05	3	-	0.05
Rimsulfuron	-	-	0.01	-	-	0.01	-	-	0.01
Saflufenacil	0.03	0.01	0.03	0.03	0.01	0.03	0.03	0.01	0.03
Sedaxane	-	-	-	0.01	0.01	0.01	-	-	-
S-metolachlor	-	-	0.05	-	-	0.05	-	-	0.05
Spinetoram	1	-	0.05	0.04	-	0.05	-	-	0.05
Spinosad	1.5	1	2	1.5	1	2	1.5	1	2
Spirotetramat	-	-	0.1	-	-	0.1	-	-	0.1
Sulfoxaflor	-	-	0.01	-	-	0.04	-	-	0.01

Table 16. Tolerances established on Cereal Grains (continued)

(Data from mrldatabase.com; tolerances as of December 1, 2016; note that shading indicates a crop definition, group or subgroup tolerance); MRLs in parentheses are more restrictive than the US MRL.

	Millet, proso, grain (ppm)			Oat, grain (ppm)			Rice, grain (ppm)		
Sulfuryl fluoride	0.1	0.05	0.05	0.1	0.05	0.05	0.04	0.05	0.05
TCMTB	-	-	-	0.1	-	-	0.1	-	-
Tebuconazole	-	-	0.02	0.15	2	2	-	1.5	1
Tepraloxydim	-	-	0.1	-	-	0.1	-	-	0.1
Tetraconazole	-	-	0.05	-	-	0.1	-	-	0.05
Thiabendazole	-	-	-	0.05	-	0.05	-	-	-
Thiamethoxam	0.02	-	0.01	0.02	-	0.02	0.02	-	0.01
Thifensulfuron-methyl	-	-	-	0.05	-	0.01	0.05	-	0.01
Thiobencarb	-	-	-	-	-	-	0.2	-	0.01
Thiophanate-methyl	-	-	0.01	-	-	0.3	-	2	0.01
Triadimenol	-	-	-	0.05	0.2	0.2	-	-	-
Tribenuron Methyl	-	-	0.01	0.05	-	0.01	0.05	-	0.01
Triclopyr	-	-	-	-	-	-	0.3	-	1
Tricyclazole	-	-	-	-	-	-	3	-	1
Trifloxystrobin	-	-	0.01	0.05	-	0.4	3.5	5	5
Triticonazole	0.01	-	0.01	-	-	-	-	-	-
Trinexapac-ethyl	-	-	-	4	3	3	0.4	-	0.02
Triticonazole	0.01	-	0.01	0.01	-	0.01	-	-	-
Zeta-Cypermethrin	0.05	0.3	0.3	3	2	2	1.5	2	2

Table 16. Tolerances established on Cereal Grains (continued)
(Data from mrldatabase.com; tolerances as of December 1, 2016; note that shading indicates a crop definition, group or subgroup tolerance); MRLs in parentheses are more restrictive than the US MRL.

	Rice, wild, grain (ppm)			Rye, grain (ppm)			Sorghum, grain (ppm)		
Compound	US	Codex	EU	US	Codex	EU	US	Codex	EU
2,4-D	0.05	-	0.1	2	2	2	0.2	0.01	0.05
Abamectin	0.01	-	0.01	0.01	-	0.01	0.01	-	0.01
Acephate	0.02	-	0.01	0.02	-	0.01	0.02	-	0.01
Acetamiprid	0.01	-	0.01	0.01	-	0.01	0.01	-	0.01
Acetochlor	-	-	-	-	-	-	0.05	-	0.01
Alachlor	-	-	-	-	-	-	0.1	-	0.01
Aldicarb	-	-	-	-	-	-	0.2	0.1	0.02
Alpha-Cypermethrin	-	-	-	-	-	-	0.5	0.3	0.3
Aminopyralid	-	-	0.01	-	-	0.1	-	-	0.01
Atrazine	-	-	-	-	-	-	0.2	-	0.05
Azoxystrobin	5	-	5	0.2	0.2	0.5	11	10	10
Benoxacor	-	-	-	-	-	-	0.01	-	-
Bentazon	-	-	-	-	-	-	0.05	0.01	0.1
Benzovindiflupyr	-	-	0.01	0.1	-	0.04	-	-	0.01
Beta-cyfluthrin	-	-	0.02	0.15	-	0.04	3.5	-	0.02
Bifenthrin	0.05	-	0.05	0.05	-	0.05	0.05	-	0.05
Boscalid	-	0.1	0.15	-	0.5	0.8	-	0.1	0.15
Bromoxynil	-	-	0.01	0.05	-	0.05	0.2	-	0.05
Captan	0.05	-	0.07	0.05	-	0.07	0.05	-	0.07
Carbaryl	-	-	0.01	-	-	0.5	10	10	0.5
Carfentrazone-ethyl	0.1	-	0.05	0.1	-	0.05	0.25	-	0.05
Chlorantraniliprole	6	0.02	0.4	6	0.02	0.02	6	0.02	0.02
Chlorfenapyr	0.01	-	0.02	0.01	-	0.02	0.01	-	0.02
Chlorpyrifos	0.1	-	0.05	0.1	-	0.05	0.5	0.5	0.05
Chlorpyrifos-methyl	-	-	-	-	-	-	6	10	3
Clothianidin	-	-	-	0.01	-	0.02	0.01	0.01	0.01
Cyfluthrin	0.05	-	0.02	0.15	-	0.04	3.5	-	0.02
Cyhalofop-butyl	0.4	-	0.01	-	-	-	-	-	-
Cyproconazole	-	0.08	0.1	-	-	-	-	-	0.1
d-Phenothrin	0.01	-	0.05	0.01	-	0.05	0.01	-	0.05
Deltamethrin	1	2	2	1	2	2	1	2	2
Dicamba	-	-	0.3	2	-	0.5	4	4	4
Dichlormid	-	-	-	-	-	-	0.05	-	-
Dichlorvos	-	-	0.01	-	-	0.01	-	-	0.01
Difenoconazole	-	-	3	0.01	-	0.1	-	-	0.05
Diflubenzuron	-	-	0.05	-	-	0.1	-	-	0.05
Dimethenamid	-	-	-	-	-	-	0.01	0.01	0.01
Dimethenamid-P	-	-	-	-	-	-	0.01	0.01	0.01
Dimethoate	-	-	-	-	-	-	0.1	-	0.02
Dinotefuran	0.01	-	-	0.01	-	-	0.01	-	-
Diquat dibromide	0.02	-	0.05	0.02	-	0.05	0.02	2	0.05
Diuron	-	-	0.01	-	-	0.01	0.5	-	0.01
Esfenvalerate	0.05	-	0.02	0.05	-	0.05	5	-	0.02
Etofenprox	5	-	0.5	5	-	0.5	5	-	0.5
Etridiazole	-	-	-	-	-	-	0.1	-	0.05
Fenbuconazole	-	-	0.05	-	0.1	0.1	-	-	0.05
Fenpyroximate	-	-	0.05	-	-	0.05	-	-	0.05

Table 16. Tolerances established on Cereal Grains (continued)

(Data from mrldatabase.com; tolerances as of December 1, 2016; note that shading indicates a crop definition, group or subgroup tolerance); MRLs in parentheses are more restrictive than the US MRL.

	Rice, wild, grain (ppm)			Rye, grain (ppm)			Sorghum, grain (ppm)		
Florasulam	-	-	-	0.01	-	0.01	-	-	0.01
Flubendiamide	-	-	0.2	-	-	0.01	5	-	0.01
Fludioxonil	0.02	0.05	0.01	0.02	0.05	0.05	0.02	0.05	0.01
Flumioxazin	-	-	0.02	-	-	-	-	-	0.02
Fluopyram	4	-	0.01	4	-	0.8	4	-	1.5
Fluoride	25	-	2	-	-	2	40	-	2
Fluoxastrobin	-	-	0.05	-	-	0.5	1.5	-	0.05
Flupyradifurone	3	-	0.01	3	-	0.01	3	-	0.01
Fluroxypyr	-	-	0.01	-	-	0.1	0.02	-	0.05
Flutriafol	-	-	1.5	-	-	0.15	1.5	1.5	0.01
Fluxapyroxad	3	-	5	3	0.3	0.4	3	0.7	0.7
Furilazole	-	-	1.5	-	-	-	0.01	-	-
Gamma Cyhalothrin	0.01	-	-	0.01	0.05	-	0.2	-	-
Glufosinate-ammonium	-	-	0.9	-	-	0.1	-	-	0.1
Glyphosate	0.1	30	0.1	30	30	10	30	30	20
Halosulfuron-methyl	-	-	-	-	-	-	0.05	-	0.01
Hexythiazox	-	-	0.5	-	-	0.5	3	-	0.5
Hydroprene	0.2	-	-	0.2	-	-	0.2	-	-
Imidacloprid	-	0.05	1.5	0.05	0.05	0.1	0.05	0.05	0.05
Indoxacarb	-	-	0.01	-	-	0.01	-	-	0.01
Inorganic bromide resulting from fumigation with methyl bromide	-	50	50	50	50	50	50	50	50
Ipconazole	0.01	-	0.01	0.01	-	0.01	0.01	-	0.01
Isoxaflutole	-	-	0.02	-	-	0.02	-	-	0.02
Lambda Cyhalothrin	1	-	1	0.05	0.05	0.05	0.2	-	0.02
Linuron	-	-	-	-	-	-	0.25	-	0.05
Malathion	8	-	8	8	-	8	8	3	8
Mancozeb	-	-	-	1	-	1	0.25	-	0.05
MCPA	-	-	0.05	1	0.2	0.2	-	-	0.05
Mefenpyr-diethyl	-	-	-	-	-	-	0.04	-	-
Mesotrione	-	-	-	-	-	-	0.01	-	0.05
Mesosulfuron-methyl	-	-	0.01	-	-	0.01	-	-	0.01
Mesotrione	-	-	-	-	-	-	0.01	0.01	0.01
Metalaxyl	0.1	0.05	0.05	0.1	0.05	0.05	0.1	0.05	0.05
Metalaxyl-M (Mefenoxam)	0.1	0.05	0.05	0.1	-	0.05	0.1	0.05	0.05
Metconazole	-	-	0.02	0.25	-	0.06	-	-	0.02
Methidathion	-	-	-	-	-	-	0.2	0.2	0.2
Methomyl	-	-	-	1	-	0.02	0.2	-	0.02
Methoxyfenozide	-	-	0.01	-	-	0.01	6	-	0.01
Metolachlor	-	-	-	-	-	-	0.3	-	0.05
Metsulfuron-methyl	-	-	-	-	-	-	0.1	-	0.01
MGK 264	5	-	-	5	-	-	5	-	-

Table 16. Tolerances established on Cereal Grains (continued)

(Data from mrldatabase.com; tolerances as of December 1, 2016; note that shading indicates a crop definition, group or subgroup tolerance); MRLs in parentheses are more restrictive than the US MRL.

	Rice, wild, grain (ppm)			Rye, grain (ppm)			Sorghum, grain (ppm)		
Myclobutanil	-	-	0.02	-	-	0.02	-	-	0.02
Naled	0.5	-	-	0.5	-	-	0.5	-	-
Nicosulfuron	-	-	-	-	-	-	0.8	-	0.01
Nitrapyrin	-	-	-	-	-	-	0.1	-	-
Novaluron	0.01	-	0.01	0.01	-	0.01	3	-	0.01
Oxydemeton-methyl	-	-	-	-	-	-	0.75	-	0.01
Paraquat dichloride	-	-	0.05	-	-	0.02	0.05	0.03	0.02
Pendimethalin	-	-	-	-	-	-	0.1	-	0.05
Penflufen	0.01	-	-	0.01	-	-	0.01	-	-
Penthiopyrad	-	-	0.01	0.15	0.1	0.1	0.8	0.8	0.8
Permethrin	-	2	0.05	-	2	0.05	-	2	0.05
Phorate	-	-	-	-	-	-	0.05	0.05	0.05
Phosphine	0.01	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Picloram	-	-	0.01	-	-	0.01	-	-	0.2
Picoxystrobin	0.04	-	0.01	0.04	-	0.05	0.04	-	0.01
Piperonyl Butoxide	10	30	-	20	30	-	8	30	-
Pirimiphos-methyl	-	7	0.5	-	7	0.5	8	7	5
Prallethrin	1	-	-	1	-	-	1	-	-
Propachlor	-	-	-	-	-	-	0.25	-	0.02
Propargite	-	-	0.01	-	-	0.01	5	-	0.01
Propazine	-	-	-	-	-	-	0.25	-	-
Propetamphos	0.1	-	-	0.1	-	-	0.1	-	-
Propiconazole	0.5	-	1.5	0.3	0.09	0.04	3.5	-	0.01
Prosulfuron	0.01	-	0.01	0.01	-	0.01	0.01	-	0.01
Prothioconazole	0.35	-	0.01	0.35	0.05	0.05	0.35	-	0.05
Pyraclostrobin	-	-	0.02	0.04	0.2	0.2	0.6	0.5	0.5
Pyrasulfotole	-	-	0.02	0.02	-	0.02	0.7	-	0.02
Pyrethrins	1	0.3	3	3	0.3	3	1	0.3	3
Pyriproxyfen	1.1	-	0.05	1.1	-	0.05	1.1	-	0.05
Quinclorac	-	-	5	-	-	0.01	6	-	0.01
Quizalofop-ethyl	-	-	0.05	-	-	0.05	0.2	-	0.05
Resmethrin	3	-	0.05	3	-	0.05	3	-	0.05
Rimsulfuron	-	-	0.01	-	-	0.01	0.01	-	0.01
S-metolachor	-	-	0.05	-	-	-	0.3	-	0.05
Saflufenacil	0.03	0.01	0.03	0.03	0.01	0.03	0.03	0.01	0.03
Sedaxane	-	-	-	0.01	0.01	0.01	0.01	0.01	0.01
S-metolachlor	-	-	-	-	-	0.05	0.3	-	0.05
Spinetoram	0.04	-	0.05	0.04	-	0.05	1	-	0.05
Spinosad	1.5	1	2	1.5	1	2	1.5	1	2
Spirotetramat	-	-	0.1	-	-	0.1	-	-	0.1
Sulfoxaflor	-	-	0.01	-	-	0.01	0.3	-	0.01
Sulfuryl fluoride	0.05	0.05	0.05	-	0.05	0.05	0.1	0.05	0.05

Table 16. Tolerances established on Cereal Grains (continued)

(Data from mrldatabase.com; tolerances as of December 1, 2016; note that shading indicates a crop definition, group or subgroup tolerance); MRLs in parentheses are more restrictive than the US MRL.

	Rice, wild, grain (ppm)			Rye, grain (ppm)			Sorghum, grain (ppm)		
TCMTB	-	-	-	-	-	-	0.1	-	-
Tebuconazole	-	-	1	-	0.15	0.3	-	-	0.02
Tepraloxydim	-	-	0.1	-	-	0.1	-	-	0.1
Terbufos	-	-	-	-	-	-	0.05	0.01	0.01
Tetraconazole	-	-	0.05	-	-	0.05	-	-	0.05
Thiabendazole	-	-	-	0.05	-	0.05			
Thiamethoxam	0.02	-	0.01	0.02	-	0.02	0.02	-	0.01
Thifensulfuron-methyl	-	-	-	-	-	-	0.05	-	0.01
Thiophanate-methyl	-	-	0.01	-	0.1	0.05	-	-	0.01
Triadimenol	-	-	-	0.05	0.2	0.2	-	-	-
Tribenuron Methyl	-	-	0.01	-	-	0.01	0.05	-	0.01
Trifloxystrobin	-	-	5	-	-	0.3	-	-	0.01
Trifluralin	-	-	-	-	-	-	0.05	-	0.01
Trinexapac-ethyl	0.4	-	0.02	4	-	0.5	-	-	-
Triticonazole	0.01	-	0.01	0.01	-	0.01	0.01	-	0.01
Zeta-Cypermethrin	1.5	0.3	2	3	2	2	0.5	0.3	0.3

Table 16. Tolerances established on Cereal Grains (continued)
(Data from mrldatabase.com; tolerances as of December 1, 2016; note that shading indicates a crop definition, group or subgroup tolerance); MRLs in parentheses are more restrictive than the US MRL.

	Teosinte, grain (ppm)			Triticale, grain (ppm)			Wheat, grain (ppm)		
Compound	US	Codex	EU	US	Codex	EU	US	Codex	EU
2,4-D	-	-	0.05	2	-	2	2	2	2
Abamectin	0.01	-	0.01	0.01	-	0.01	0.01	-	0.01
Acephate	0.02	-	0.01	0.02	-	0.01	0.02	-	0.01
Acetamiprid	0.01	-	0.01	0.01	-	0.1	0.01	-	0.1
Alpha-Cypermethrin	-	-	-	0.2	0.3	2	0.2	2	2
Aminopyralid	-	-	0.01	0.04	0.1	0.1	0.04	0.1	0.1
Atrazine	-	-	-	0.1	-	0.05	0.1	-	0.05
Azoxystrobin	-	-	0.01	0.2	0.2	0.5	0.2	0.2	0.5
Benzovindiflupyr	-	-	0.01	0.1	-	0.04	0.1	-	0.04
Beta-cyfluthrin	0.05	-	0.02	0.15	-	0.04	0.15	-	0.04
Bifenthrin	0.05	-	0.05	0.05	-	0.5	0.05	0.5	0.5
Boscalid	-	0.1	0.15	-	0.1	0.8	-	0.5	0.8
Bromoxynil	-	-	0.01	0.05	-	0.05	0.05	-	0.05
Captan	0.05	-	0.07	0.05	-	0.07	0.05	-	0.07
Carbaryl	-	-	0.5	1	-	0.5	1	2	0.5
Carboxin	-	-	-	0.2	-	0.01	0.2	-	0.01
Carfentrazone-ethyl	0.1	-	0.05	0.1	-	0.05	0.1	-	0.05
Chlorantraniliprole	6	0.02	0.02	6	0.02	0.02	6	0.02	0.02
Chlorfenapyr	0.01	-	0.02	0.01	-	0.02	0.01	-	0.02
Chlorpyrifos	0.1	-	0.05	0.5	-	0.05	0.5	0.5	0.05
Chlorpyrifos-methyl	-	-	-	6	-	3	6	10	3
Chlorsulfuron	-	-	-	0.1	-	0.1	0.1	-	0.1
Clodinafop-propargyl	-	-	-	0.02	-	0.02	0.02	-	0.02
Clopyralid	-	-	-	3	-	2	3	-	2
Cloquintocet-mexyl	-	-	-	0.1	-	-	0.1	-	-
Clothianidin	0.01	-	0.01	0.01	-	0.04	0.01	0.02	0.02
Cyfluthrin	0.05	-	0.02	0.15	-	0.04	0.15	-	0.04
Cyproconazole	-	0.08	0.1	0.05	0.08	0.1	0.05	0.08	0.1
d-Phenothrin	0.01	-	0.05	0.01	-	0.05	0.01	-	0.05
Deltamethrin	1	2	2	1	2	2	1	2	2
Dicamba	-	-	0.3	2	-	2	2	2	2
Dichlorvos	-	-	0.01	-	-	0.01	-	7	0.01
Diclofop-Methyl	-	-	-	0.1	-	0.05	0.1	-	0.05
Difenoconazole	-	-	0.05	0.1	-	0.1	0.1	0.02	0.1
Diflubenzuron	-	-	0.05	0.06	0.05	0.1	0.06	0.05	0.1
Dimethoate	-	-	-	0.04	-	0.05	0.04	0.05	0.05
Dinotefuran	0.01	-	-	0.01	-	-	0.01	-	-
Diquat dibromide	0.02	-	0.05	0.02	-	0.05	0.02	2	0.05
Diuron	-	-	0.01	0.5	-	0.01	0.5	-	0.01
Esfenvalerate	0.05	-	0.02	0.05	-	0.05	0.05	0.05	0.05
Ethephon	-	-	-	2	0.5	1	2	0.5	1
Etofenprox	5	-	0.5	5	-	0.5	5	-	0.5
Etridiazole	-	-	-	0.1	-	0.05	0.1	-	0.05
Fenbuconazole	-	-	0.05	0.1	-	0.1	0.1	0.1	0.1
Fenitrothion	-	-	-	-	-	-	-	6	0.05
Fenoxaprop-Ethyl	-	-	-	0.05	-	-	0.05	-	-

Table 16. Tolerances established on Cereal Grains (continued)

(Data from mrldatabase.com; tolerances as of December 1, 2016; note that shading indicates a crop definition, group or subgroup tolerance); MRLs in parentheses are more restrictive than the US MRL.

	Teosinte, grain (ppm)			Triticale, grain (ppm)			Wheat, grain (ppm)		
Fenpyroximate	-	-	0.05	-	-	0.05	-	-	0.05
Florasulam	-	-	-	0.01	-	0.01	0.01	-	0.01
Flubendiamide	-	-	0.01	0.01	-	0.01	0.01	-	0.01
Flucarbazone-sodium	-	-	-	0.01	-	-	0.01	-	-
Fludioxonil	0.02	0.05	0.01	0.02	0.05	0.01	0.02	0.05	0.01
Flufenacet	-	-	-	0.6	-	0.1	0.6	-	0.1
Flumioxazin	-	-	0.02	0.4	-	0.02	0.4	0.4	0.02
Fluopyram	4	-	0.1	4	-	0.8	4	-	0.8
Fluoride	-	-	2	40	-	2	40	-	2
Fluoxastrobin	-	-	0.05	0.15	-	0.05	0.15	-	0.05
Flupyradifurone	3	-	0.01	3	-	0.01	3	-	0.01
Fluroxypyr	-	-	0.01	0.5	-	0.1	0.5	-	0.1
Flutriafol	-	-	0.01	0.15	-	0.15	0.15	0.15	0.15
Fluxapyroxad	3	-	0.01	0.3	0.3	0.4	0.3	0.3	0.4
Gamma Cyhalothrin	0.01	-	-	0.05	0.05	-	0.05	0.05	-
Glufosinate-ammonium	-	-	0.1	-	-	0.1	-	-	0.1
Glyphosate	30	30	0.1	30	30	10	30	30	10
Hexythiazox	-	-	0.05	0.02	-	0.5	0.02	-	0.5
Hydroprene	0.2	-	-	0.2	-	-	0.2	-	-
Imazalil	-	-	-	0.1	-	0.05	0.1	0.01	0.05
Imazamethabenz	-	-	-	0.1	-	-	0.1	-	-
Imidacloprid	0.05	0.05	0.05	0.05	0.05	0.1	0.05	0.05	0.1
Indoxacarb	-	-	0.01	-	-	0.01	-	-	0.01
Inorganic bromide resulting from fumigation with methyl bromide	-	50	50	50	50	50	50	50	50
Iodosulfuron-methyl	-	-	-	0.02	-	0.01	0.02	-	0.01
Ipconazole	0.01	-	0.01	0.01	-	0.01	0.01	-	0.01
Isoxaflutole	-	-	0.02	-	-	0.02	-	-	0.02
Lambda Cyhalothrin	0.01	-	0.02	0.05	0.05	0.05	0.05	0.05	0.05
Linuron	-	-	-	0.05	-	0.05	0.05	-	0.05
Malathion	-	-	-	8	-	8	8	10	8
Mancozeb	-	-	-	1	-	1	1	1	1
MCPA	-	-	0.05	1	0.2	0.2	1	0.2	0.2
Mefenpyr-diethyl	-	-	-	0.05	-	-	0.05	-	-
Mesosulfuron-methyl	-	-	0.01	0.03	-	0.01	0.03	-	0.01
Metalaxyl	0.1	0.05	0.05	0.1	0.05	0.05	0.1	0.05	0.05
Metalaxyl-M (Mefenoxam)	0.1	0.05	0.05	0.1	0.05	0.05	0.1	0.05	0.05
Metaldehyde	-	-	-	0.05	-	0.05	0.05	-	0.05
Metconazole	-	-	0.02	0.15	-	0.15	0.15	-	0.15
Methomyl	-	-	-	1	-	0.02	1	2	0.02
Methoxyfenozide	-	-	0.01	-	-	0.01	-	-	0.01

Table 16. Tolerances established on Cereal Grains (continued)

(Data from mrldatabase.com; tolerances as of December 1, 2016; note that shading indicates a crop definition, group or subgroup tolerance); MRLs in parentheses are more restrictive than the US MRL.

	Teosinte, grain (ppm)			Triticale, grain (ppm)			Wheat, grain (ppm)		
Metribuzin	-	-	-	0.75	-	0.1	0.75	-	0.1
Metsulfuron-methyl	-	-	-	0.1	-	0.01	0.1	-	0.01
MGK 264	5	-	-	5	-	-	5	-	-
Myclobutanil	-	-	0.02	-	-	0.02	-	-	0.02
Naled	0.5	-	-	0.5	-	-	0.5	-	-
Nitrapyrin	-	-	-	0.5	-	-	0.5	-	-
Novaluron	0.01	-	0.01	0.01	-	0.01	0.01	-	0.01
Paraquat dichloride	-	-	0.02	1.1	-	0.02	1.1	-	0.02
Pendimethalin	-	-	-	0.1	-	0.05	0.1	-	0.05
Penflufen	0.01	-	-	0.01	-	-	0.01	-	-
Penthiopyrad	0.15	-	0.01	0.15	0.1	0.1	0.15	0.1	0.1
Permethrin	-	2	0.05	-	2	0.05	-	2	0.05
Phorate	-	-	-	0.05	-	0.02	0.05	-	0.02
Phosphine	0.01	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Picloram	-	-	0.2	0.5	-	0.2	0.5	-	0.2
Picoxystrobin	0.04	-	0.01	0.04	-	0.05	0.04	-	0.05
Pinoxaden	-	-	-	1.3	-	1	1.3	-	1
Piperonyl Butoxide	10	30	-	20	30	-	20	30	-
Pirimiphos-methyl	-	7	0.5	-	7	5	-	7	5
Prallethrin	1	-	-	1	-	-	1	-	-
Propargite	-	-	0.01	-	-	0.01	-	-	0.01
Propetamphos	0.1	-	-	0.1	-	-	0.1	-	-
Propiconazole	-	-	0.01	0.3	0.09	0.04	0.3	0.09	0.04
Propoxycarbazone	-	-	-	0.02	-	0.02	0.02	-	0.02
Prosulfuron	0.01	-	0.01	0.01	-	0.01	0.01	-	0.01
Prothioconazole	0.35	-	0.01	0.35	0.05	0.1	0.35	0.1	0.1
Pyraclostrobin	-	-	0.02	0.02	0.2	0.2	0.02	0.2	0.2
Pyraflufen-ethyl	-	-	-	0.01	-	0.02	0.01	-	0.02
Pyrasulfotole	-	-	0.02	0.02	-	0.02	0.02	-	0.02
Pyrethrins	1	0.3	3	3	0.3	3	3	0.3	3
Pyriproxyfen	1.1	-	0.05	1.1	-	0.05	1.1	-	0.05
Pyroxsulfone	-	-	-	0.03	-	-	0.03	-	-
Pyroxsulam	-	-	-	0.01	-	0.01	0.01	-	0.01
Quinclorac	-	-	0.01	0.5	-	0.01	0.5	-	0.01
Quizalofop-ethyl	-	-	0.05	0.05	-	0.05	0.05	-	0.05
Resmethrin	3	-	0.05	3	-	0.05	3	1	0.05
Rimsulfuron	-	-	0.01	-	-	0.01	-	-	0.01
Saflufenacil	0.03	0.01	0.03	0.6	0.01	0.03	0.6	0.01	0.03
Sedaxane	-	-	-	0.01	0.01	0.01	0.01	0.01	0.01
S-metolachlor	-	-	0.05	-	-	0.05	-	-	0.05
Spinetoram	0.04	-	0.05	0.04	-	0.05	0.04	-	0.05
Spinosad	1.5	1	2	1.5	1	2	1.5	1	2

Table 16. Tolerances established on Cereal Grains (continued)

(Data from mrldatabase.com; tolerances as of December 1, 2016; note that shading indicates a crop definition, group or subgroup tolerance); MRLs in parentheses are more restrictive than the US MRL.

	Teosinte, grain (ppm)			Triticale, grain (ppm)			Wheat, grain (ppm)		
Spirotetramat	-	-	0.1	-	-	0.1	-	-	0.1
Sulfentrazone	-	-	-	0.15	-	-	0.15	-	-
Sulfosulfuron	-	-	-	0.02	-	0.02	0.02	-	0.02
Sulfoxaflor	-	-	0.01	0.08	0.2	0.09	0.08	0.2	0.09
Sulfuryl fluoride	-	0.05	0.05	0.1	0.05	0.05	0.1	0.05	0.05
TCMTB	-	-	-	0.1	-	-	0.1	-	-
Tebuconazole	-	-	0.02	0.15	0.15	0.3	0.15	0.15	0.3
Tepraloxydim	-	-	0.1	-	-	0.1	-	-	0.1
Tetraconazole	-	-	0.05	-	-	0.1	-	-	-
Thiabendazole	-	-	-	0.05	-	0.05	0.05	-	0.05
Thiamethoxam	0.02	-	0.01	0.02	-	0.05	0.02	0.05	0.05
Thiencarbazone-methyl	-	-	-	0.01	-	-	0.01	-	-
Thifensulfuron-methyl	-	-	-	0.05	-	0.01	0.05	-	0.01
Thiophanate-methyl	-	-	0.01	0.1	-	0.05	0.1	0.05	0.05
Tralkoxydim	-	-	-	0.02	-	0.02	0.02	-	0.02
Tri-Allate	-	-	-	0.05	-	0.1	0.05	-	0.1
Triadimenol	-	-	-	0.05	0.2	0.2	0.05	0.2	0.2
Triasulfuron	-	-	-	0.02	-	0.05	0.02	-	0.05
Tribenuron Methyl	-	-	0.01	0.05	-	0.01	0.05	-	0.01
Trifloxystrobin	-	-	0.01	0.05	-	0.3	0.05	0.2	0.3
Trifluralin	-	-	-	0.05	-	0.01	0.05	-	0.01
Trinexapac-ethyl	-	-	-	4	3	3	4	3	3
Triticonazole	0.01	-	0.01	0.01	-	0.01	0.01	-	0.01
Zeta-Cypermethrin	0.05	0.3	0.3	0.2	0.3	2	0.2	2	2
Zinc phosphide	-	-	-	0.05	0.1	0.1	0.05	0.1	0.1

Tolerances for Cereal Grain Group 16.

Appendix 8. Residue Levels – Forage, Fodder and Straw of Cereal Grains Group 16:

Table 17. Tolerances established on Forage, Fodder and Straw of Cereal Grains
(Data provided by Bryant Christie Inc. on January 6, 2017; note that shading indicates a crop definition, group or subgroup tolerance); MRLs in parentheses are more restrictive than the US MRL.

	Barley, forage (ppm)		Barley, straw (ppm)		Barley, fodder (ppm)		Barley, hay (ppm)	
Compound	US	Codex	US	Codex	US	Codex	US	Codex
2-(Thiocyanomethylthio)benzothiazole	-	-	0.1	-	-	-	-	-
2,4-D	-	-	50	-	-	400	-	400
Acetochlor	-	-	-	0.3	-	0.3	-	-
Aldicarb	-	-	-	0.05	-	0.05	-	-
Alpha-cypermethrin	-	-	-	10	-	10	-	-
Aminocyclopyrachlor	-	-	-	-	-	150	-	150
Aminopyralid	-	-	-	0.3	-	3	-	70
Azoxystrobin	25	-	15	15	10	15	10	-
Benomyl	-	-	-	2	-	2	-	-
Bentazon	-	-	-	0.3	-	0.3	-	2
Benzovindiflupyr	-	-	15	15	-	-	15	-
Beta-cyfluthrin	25	-	7	10	30	10	6	-
Bicyclopyrone	-	-	0.4	-	-	-	0.3	-
Bifenthrin	-	-	-	0.5	-	0.5	-	-
Bitertanol	-	-	-	0.05	-	0.05	-	-
Bixafen	4	-	7	20	6	20	5	-
Boscalid	-	-	-	5	-	5	-	-
Bromoxynil	-	-	4	-	-	-	9	-
Captan	0.05	-	0.05	-	0.05	-	-	-
Carbendazim	-	-	-	2	-	2	-	-
Carboxin disulfide	-	-	-	25	-	25	-	-
Carboxin	-	-	0.2	-	-	-	-	-
Carfentrazone-ethyl	1	-	3	-	0.8	-	0.3	-
Chlorantraniliprole	40	-	40	0.3	40	0.3	-	-
Chlormequat	-	-	-	30	-	30	-	-
Chlorsulfuron	-	-	0.5	-	-	-	-	-
Clopyralid	-	-	9	-	-	-	9	-
Cloquintocet-mexyl	-	-	0.1	-	-	-	0.1	-
Clothianidin	0.35	-	0.05	0.2	0.1	0.2	0.07	-
Cyantraniliprole	-	-	-	0.2	-	0.2	-	0.2
Cyfluthrin	25	-	7	-	30	-	6	-
Cyhalothrin	-	-	-	2	-	2	-	-
Cypermethrin	-	-	-	10	-	10	-	-
Cyproconazole	-	-	-	5	-	5	-	-
Cyprodinil	-	-	-	10	-	10	-	-
Dicamba	-	-	15	50	-	50	2	30
Dichlobenil	-	-	-	0.4	-	0.4	-	-
Diclofop-methyl	-	-	0.1	-	-	-	-	-
Difenoconazole	-	-	0.05	-	-	-	0.05	-
Diflubenzuron	-	-	1.8	1.5	-	1.5	3	3
Diquat dibromide	0.02	-	0.02	-	0.02	-	-	-
Disulfoton	-	-	-	3	-	3	-	-
Diuron	-	-	2	-	-	-	2	-
Ethephon	-	-	10	7	-	7	-	-

Table 17. Tolerances established on Forage, Fodder and Straw of Cereal Grains (continued)
(Data provided by Bryant Christie Inc. on January 6, 2017; note that shading indicates a crop definition, group or subgroup tolerance); MRLs in parentheses are more restrictive than the US MRL.

	Barley, forage (ppm)		Barley, straw (ppm)		Barley, fodder (ppm)		Barley, hay (ppm)	
Compound	US	Codex	US	Codex	US	Codex	US	Codex
Famoxadone		-	-	5	-	5	-	.-
Fenbuconazole		-	-	3	-	3	-	-
Fenoxaprop-ethyl	-	-	0.1	-	-	-	-	-
Fenoxaprop-p-ethyl		-	0.1	-		-	-	-
Fenpropathrin	-	-	2	-	-	-	3	-
Fenpropimorph	-	-	-	5	-	5	-	-
Ferbam	-	-	-	25	-	25	-	-
Florasulam	-	-	0.05	-	-	-	0.05	-
Fludioxonil	0.01	-	0.01	0.06	0.01	0.06	-	-
Fluopicolide	-	-	-	0.2	-	0.2	-	-
Fluopyram	20	-	20	-	20	-	-	-
Fluroxypyr	12	-	12	-	-	-	20	-
Fluroxypyr-meptyl	12	-	12	-	-	-	20	-
Flusilazole	-	-	-	5	-	5	-	-
Fluxapyroxad	20	-	20	30	20	30	-	-
Gamma cyhalothrin	-	-	-	2	-	2	-	-
Glyphosate	-	-	-	400	100	400	-	500
Halauxifen-methyl	-	-	0.01	-	-	-	0.01	-
Imazalil	-	-	0.5	-	-	-	0.5	-
Imazapic-ammonium	-	-	-	-	-	6	-	6
Imidacloprid	7	-	3	1	0.3	1	6	-
Ipconazole	0.01	-	0.01	-	0.01	-	-	-
Isopyrazam	-	-	-	3	-	3	-	-
Kresoxim-methyl	-	-	-	5	-	5	-	-
Lambda cyhalothrin	-	-	2	2	-	2	2	-
Lindane	-	-	-	0.01	-	0.01	-	-
Malathion	-	-	50	-	-	-	-	-
Mancozeb	-	-	25	25	-	25	30	-
Maneb	-	-	-	25	-	25	-	-
MCPA	-	-	25	50	-	50	40	500
Mefenpyr-diethyl	-	-	0.5	-	-	-	0.2	-
Metconazole	-	-	7	-	-	-	7	-
Methiocarb	-	-	-	0.05	-	0.05	-	-
Methomyl	-	-	10	10	-	10	10	10
Metiram	-	-	-	25	-	25	-	-
Metrafenone	-	-	-	6	-	6	-	-
Metribuzin	-	-	1	-	-	-	7	-
Metsulfuron-methyl	-	-	0.3	-	-	-	20	-
Myclobutanil	-	-	-	0.3	-	0.3	-	-
Oxydemeton-methyl	-	-	-	0.1	-	0.1	-	-
Paraquat dichloride	-	-	1	-	-	-	3.5	-
Penflufen	0.01	-	0.01	-	0.01	-	-	-

Table 17. Tolerances established on Forage, Fodder and Straw of Cereal Grains (continued)
(Data provided by Bryant Christie Inc. on January 6, 2017; note that shading indicates a crop definition, group or subgroup tolerance); MRLs in parentheses are more restrictive than the US MRL.

	Barley, forage (ppm)		Barley, straw (ppm)		Barley, fodder (ppm)		Barley, hay (ppm)	
Compound	US	Codex	US	Codex	US	Codex	US	Codex
Pentachloronitrobenzene	-	-	-	0.01	-	0.01	-	-
Penthiopyrad	-	-	1	80	-	80	80	-
Picloram	-	-	1	-	-	-	-	-
Picoxystrobin	15	-	2	-	10	-	5	-
Pinoxaden	-	-	1	-	-	-	1.5	-
Pirimicarb	-	-	-	0.3	-	0.3	-	-
Prochloraz	-	-	-	40	-	40	-	-
Propiconazole	-	-	20	8	-	8	30	-
Propineb	-	-	-	25	-	25	-	-
Prosulfuron	0.1	-	0.02	-	0.01	-	0.2	-
Prothioconazole	8	-	5	4	10	5	7	-
Pyraclostrobin	-	-	6	30	-	30	25	-
Pyrasulfotole	-	-	0.2	-	-	-	0.3	-
Pyriproxyfen	1.1	-	1.1	-	1.1	-	-	-
Quizalofop-ethyl	-	-	0.05	-	-	-	0.05	-
Saflufenacil	-	-	15	0.05	-	0.05	-	-
Sedaxane	-	-	0.01	-	-	0.1	0.04	0.1
Spinetoram	3.5	-	1	-	10	-	10	-
Spinosad	2.5	-	1	-	10	-	10	-
Sulfoxaflor	-	-	2	3	-	3	1	-
Tebuconazole	-	-	3.5	40	-	40	7	-
Thiabendazole	-	-	0.3	-	-	-	0.3	-
Thiamethoxam	-	-	0.4	2	-	2	0.4	-
Thifensulfuron-methyl	-	-	0.1	-	-	-	0.8	-
Thiodicarb	-	-	-	10	-	10	-	10
Thiophanate-methyl	-	-	-	2	-	2	-	-
Thiram	-	-	-	25	-	25	-	-
Triadimefon	-	-	-	5	-	5	-	-
Triadimenol	-	-	0.2	-	-	-	-	-
Triasulfuron	-	-	2	-	-	-	-	-
Tribenuron methyl	-	-	0.1	-	-	-	0.4	-
Trifloxystrobin	-	-	5	7	-	7	0.3	-
Trifluralin	-	-	0.05	-	-	-	0.05	-
Trinexapac-ethyl	-	-	0.4	0.9	-	0.9	0.8	-
Triticonazole	0.1	-	0.1	-	0.1	-	-	-
Zeta-cypermethrin	-	-	20	10	-	10	6	-
Zinc phosphide	-	-	0.2	-	-	-	0.2	-
Zineb	-	-	-	25	-	25	-	-
Ziram	-	-	-	25	-	25	-	-

Table 17. Tolerances established on Forage, Fodder and Straw of Cereal Grains (continued)
(Data provided by Bryant Christie Inc. on January 6, 2017; note that shading indicates a crop definition, group or subgroup tolerance); MRLs in parentheses are more restrictive than the US MRL.

	Buckwheat, forage (ppm)		Buckwheat, straw (ppm)		Buckwheat, fodder (ppm)		Buckwheat, hay (ppm)	
Compound	US	Codex	US	Codex	US	Codex	US	Codex
2,4-D	-	-	-	-	-	400	-	400
Acetochlor	-	-	-	-	-	0.3	-	-
Alpha-cypermethrin	-	-	-	10	-	10	-	-
Aminocyclopyrachlor	-	-	-	-	-	150	-	150
Aminopyralid	-	-	-	0.3	-	3	-	70
Azoxystrobin	-	-	-	15	-	15	-	-
Bentazon	-	-	-	-	-	2	-	2
Beta-cyfluthrin	25	-	7	-	30	-	6	-
Beta-cypermethrin	-	-	-	10	-	10	-	-
Boscalid	-	-	-	5	-	5	-	-
Captan	0.05	-	0.05	-	0.05	-	-	-
Carfentrazone-ethyl	1	-	3	-	0.8	-	0.3	-
Chlorantraniliprole	40	-	40	0.3	40	0.3	-	-
Chlormequat	-	-	-	30	-	30	-	-
Clothianidin	0.35	-	0.05	-	0.1	-	0.07	-
Cyantraniliprole	-	-	-	0.2	-	0.2	-	0.2
Cyfluthrin	25	-	7	-	30	-	6	-
Cyhalothrin	-	-	-	2	-	2	-	-
Cypermethrin	-	-	-	10	-	10	-	-
Cyproconazole	-	-	-	5	-	5	-	-
Cyprodinil	-	-	-	10	-	10	-	-
Dicamba	-	-	-	-	-	30	-	30
Dichlobenil	-	-	-	0.4	-	0.4	-	-
Diflubenzuron	-	-	-	1.5	-	1.5	-	3
Diquat dibromide	0.02	-	0.02	-	0.02	-	-	-
Fludioxonil	0.01	-	0.01	0.06	0.01	0.06	-	-
Fluopicolide	-	-	-	0.2	-	0.2	-	-
Fluopyram	20	-	20	-	20	-	-	-
Flupyradifurone	30	-	30	-	30	-	-	-
Flusilazole	-	-	-	5	-	5	-	-
Fluthiacet-methyl	0.05	-	0.05	-	0.05	-	0.05	-
Fluxapyroxad	20	-	20	-	20	-	-	-
Gamma cyhalothrin	-	-	-	20	-	20	-	-
Glyphosate	-	-	-	-	100	500	-	500
Imazapic-ammonium	-	-	-	-	-	3	-	3
Imazapyr	-	-	-	-	-	6	-	6
Imidacloprid	7	-	3	-	0.3	-	6	-
Ipconazole	0.01	-	0.01	-	0.01	-	-	-
Kresoxim-methyl	-	-	-	5	-	5	-	-
Lambda cyhalothrin	-	-	-	2	-	2	-	-
Lindane	-	-	-	0.01	-	0.01	-	-

Table 17. Tolerances established on Forage, Fodder and Straw of Cereal Grains (continued)
(Data provided by Bryant Christie Inc. on January 6, 2017; note that shading indicates a crop definition, group or subgroup tolerance); MRLs in parentheses are more restrictive than the US MRL.

	Buckwheat, forage (ppm)		Buckwheat, straw (ppm)		Buckwheat, fodder (ppm)		Buckwheat, hay (ppm)	
Compound	US	Codex	US	Codex	US	Codex	US	Codex
MCPA	-	-	-	-	-	500	-	500
Methomyl	-	-	-	10	-	10	-	-
Myclobutanil	-	-	-	0.3	-	10	-	-
Pendimethalin	-	-	-	-	-	2500	-	2500
Penflufen	0.01	-	0.01	-	0.01	-	-	-
Picoxystrobin	15	-	2	-	10	-	5	-
Pirimicarb	-	-	-	0.3	-	0.3	-	-
Prochloraz	-	-	-	40	-	40	-	-
Prosulfuron	0.1	-	0.02	-	0.01	-	0.2	-
Prothioconazole	8	-	5	4	10	5	7	-
Pyraclostrobin	-	-	-	30	-	30	-	-
Pyriproxyfen	1.1	-	1.1	-	1.1	-	-	-
Saflufenacil	0.1	-	0.1	-	0.1	-	-	-
Sedaxane	-	-	-	0.1	-	0.1	-	0.1
Spinetoram	3.5	-	1	-	10	-	10	-
Spinosad	2.5	-	1	-	10	-	10	-
Thiamethoxam	0.5	-	0.02	-	-	-	0.02	-
Thiodicarb	-	-	-	10	-	10	-	10
Triadimefon	-	-	-	5	-	5	-	-
Triticonazole	0.1	-	0.1	-	0.1	-	-	-

Table 17. Tolerances established on Forage, Fodder and Straw of Cereal Grains (continued)
(Data provided by Bryant Christie Inc. on January 6, 2017; note that shading indicates a crop definition, group or subgroup tolerance); MRLs in parentheses are more restrictive than the US MRL.

	Corn, field, forage (ppm)		Corn, field, straw (ppm)		Corn, field, fodder (ppm)		Corn, field, hay (ppm)	
Compound	US	Codex	US	Codex	US	Codex	US	Codex
2-(Thiocyanomethylthio)benzothiazole	0.1	-	-	-	0.1	-	-	-
2,4-D	6	-	-	-	50	40	-	400
Acetochlor	4.5	-	-	-	2.5	-	-	-
4-(Dichloroacetyl)-1-oxa-4-azaspiro[4.5]decane	0.005	-	-	-	0.005	-	-	-
Alachlor	2	-	-	-	2	-	-	-
Aldicarb	-	-	-	-	-	0.5	-	-
Alpha-cypermethrin	-	-	-	10	-	10	-	-
Ametryn	0.1	-	-	-	0.05	-	-	-
Amicarbazone	0.8	-	-	-	1	-	-	-
Aminocyclopyrachlor	-	-	-	-	-	150	-	150
Aminopyralid	0.3	-	-	0.3	0.2	3	-	70
Atrazine	1.5	-	-	-	0.5	-	-	-
Azoxystrobin	12	40	-	15	25	15	-	-
Benoxacor	0.01	-	-	-	0.01	-	-	-
Bentazon	3	-	-	-	3	0.4	-	2
Benzovindiflupyr	3	-	-	-	15	-	-	-
Beta-cyfluthrin	25	-	7	-	30	-	6	-
Beta-cypermethrin	-	-	-	10	-	10	-	-
Bicyclopyrone	0.3	-	-	-	0.4	-	-	-
Bifenthrin	3	-	-	-	5	15	-	-
Bixafen	4	-	7	-	6	-	5	-
Boscalid	-	-	-	5	-	5	-	-
Bromoxynil	0.3	-	-	-	0.2	-	-	-
Captan	0.05	-	0.05	-	0.05	-	-	-
Carbaryl	30	-	-	-	20	250	-	-
Carbon disulfide	-	-	-	-	-	2	-	-
Carboxin	0.2	-	-	-	0.2	-	-	-
Carfentrazone-ethyl	1	-	3	-	0.8	-	0.3	-
Chlorantraniliprole	40	-	40	0.3	40	25	-	-
Chlorethoxyphos	0.01	-	-	-	0.01	-	-	-
Chlorimuron-ethyl	0.5	-	-	-	2	-	-	-
Chlormequat	-	-	-	30	-	7	-	-
Chlorpyrifos	8	-	-	-	8	10	-	-
Clethodim	0.2	-	-	-	0.2	-	-	-
Clopyralid	3	-	-	-	10	-	-	-

Table 17. Tolerances established on Forage, Fodder and Straw of Cereal Grains (continued)
(Data provided by Bryant Christie Inc. on January 6, 2017; note that shading indicates a crop definition, group or subgroup tolerance); MRLs in parentheses are more restrictive than the US MRL.

	Corn, field, forage (ppm)		Corn, field, straw (ppm)		Corn, field, fodder (ppm)		Corn, field, hay (ppm)	
Compound	US	Codex	US	Codex	US	Codex	US	Codex
Clothianidin	0.35	-	0.05	-	0.1	0.01	0.07	-
Cycloxydim	-	-	-	-	-	2	-	-
Cyfluthrin	25	-	7	-	30	-	6	-
Cyhalothrin	-	-	-	2	-	2	-	-
Cypermethrin	-	-	-	10	-	10	-	-
Cyproconazole	0.6	-	-	5	1.2	5	-	-
Cyprodinil	-	-	-	10	-	10	-	-
Cyprosulfamide	0.2	-	-	-	0.2	-	-	-
Deltamethrin	0.7	-	-	-	5	-	-	-
Dicamba	3	-	-	-	3	0.6	-	30
Dichlobenil	-	-	-	0.4	-	0.4	-	-
Dichlormid	0.05	-	-	-	0.05	-	-	-
Diflubenzuron	-	-	-	1.5	-	1.5	-	3
Diflufenzopyr	0.05	-	-	-	0.05	-	-	-
Dimethenamid	0.01	-	-	-	0.01	0.01	-	-
Dimethenamid-p	0.01	-	-	-	0.01	0.01	-	-
Dimethoate	1	-	-	-	1	-	-	-
Diquat dibromide	0.02	-	0.02	-	0.02	-	-	-
Disulfoton	-	-	-	-	-	3	-	-
EPTC	0.08	-	-	-	0.08	-	-	-
Esfenvalerate	15	-	-	-	15	-	-	-
Ethoprop	0.02	-	-	-	0.02	-	-	-
Etoxazole	0.8	-	-	-	4	-	-	-
Fenpyroximate	2	-	-	-	7	-	-	-
Ferbam	-	-	-	-	-	2	-	-
Fipronil	0.15	-	-	-	0.3	0.1	-	-
Flubendiamide	8	-	-	-	15	-	-	-
Fludioxonil	0.01	-	0.01	0.06	0.01	0.06	-	-
Flufenacet	0.4	-	-	-	0.4	-	-	-
Flumiclorac-pentyl	0.01	-	-	-	0.01	-	-	-
Flumioxazin	0.02	-	-	-	0.02	0.02	-	-
Fluopicolide	-	-	-	0.2	-	0.2	-	-
Fluopyram	20	-	20	-	20	-	-	-
Fluoxastrobin	3	-	-	-	4.5	-	-	-
Flupyradifurone	30	-	30	-	30	-	-	-
Fluroxypyr	1	-	-	-	0.5	-	-	-
Fluroxypyr-meptyl	1	-	12	-	0.5	-	-	-
Flusilazole	-	-	-	5	-	5	-	-

Table 17. Tolerances established on Forage, Fodder and Straw of Cereal Grains (continued)
(Data provided by Bryant Christie Inc. on January 6, 2017; note that shading indicates a crop definition, group or subgroup tolerance); MRLs in parentheses are more restrictive than the US MRL.

	Corn, field, forage (ppm)		Corn, field, straw (ppm)		Corn, field, fodder (ppm)		Corn, field, hay (ppm)	
Compound	US	Codex	US	Codex	US	Codex	US	Codex
Fluthiacet-methyl	0.05	-	-	-	0.05	-	-	-
Flutriafol	5	-	-	-	15	20	-	-
Fluxapyroxad	20	-	20	-	20	15	-	-
Furilazole	0.01	-	-	-	0.01	-	-	-
Gamma cyhalothrin	-	-	-	-	-	-	-	-
Ipconazole	-	-	-	-	-	-	-	-
Gamma cyhalothrin	6	-	-	2	1	2	-	-
Glufosinate-ammonium	4	-	-	-	6	8	-	-
Glyphosate	13	-	-	-	100	150	-	500
Halosulfuron-methyl	0.2	-	-	-	0.8	-	-	-
Hexythiazox	6	-	-	-	7	-	-	-
Imazapic-ammonium	-	-	-	-	-	3	-	3
Imazapyr	0.05	-	-	-	0.05	6	-	6
Imazethapyr	0.1	-	-	-	0.1	-	-	-
Imidacloprid	7	-	3	-	0.3	0.2	6	-
Indoxacarb	-	-	-	-	-	25	-	-
Iodosulfuron-methyl	0.05	-	-	-	0.05	-	-	-
Ipconazole	0.01	-	0.01	-	0.01	-	-	-
Isoxadifen-ethyl	0.2	-	-	-	0.4	-	-	-
Isoxaflutole	0.04	-	-	-	0.02	0.02	-	-
Kresoxim-methyl	-	-	-	5	-	5	-	-
Lambda cyhalothrin	6	-	-	2	1	2	-	-
Lindane	-	-	0.01	-	-	0.01	-	-
Linuron	1	-	-	-	6	-	-	-
Malathion	8	-	-	-	30	-	-	-
Mancozeb	40	-	-	-	15	2	-	-
Maneb	-	-	-	-	-	2	-	-
MCPA	-	-	-	-	-	0.3	-	500
Mesotrione	0.01	-	-	-	0.01	-	-	-
Metaldehyde	0.3	-	-	-	0.1	-	-	-
Metconazole	3	-	-	-	30	-	-	-
Methomyl	10	-	-	10	10	10	-	10
Methoxyfenozide	15	-	-	-	125	60	-	-
Metiram	-	-	-	-	-	2	-	-
Metolachlor	6	-	-	-	6	-	-	-
Metribuzin	0.1	-	-	-	0.1	-	-	-
Myclobutanil	-	-	-	0.3	-	0.3	-	-
Nicosulfuron	0.1	-	-	-	0.1	-	-	-

Table 17. Tolerances established on Forage, Fodder and Straw of Cereal Grains (continued)
(Data provided by Bryant Christie Inc. on January 6, 2017; note that shading indicates a crop definition, group or subgroup tolerance); MRLs in parentheses are more restrictive than the US MRL.

	Corn, field, forage (ppm)		Corn, field, straw (ppm)		Corn, field, fodder (ppm)		Corn, field, hay (ppm)	
Compound	US	Codex	US	Codex	US	Codex	US	Codex
Nitrapyrin	1	-	-	-	1	-	-	-
Omethoate	1	-	-	-	1	-	-	-
Paraquat dichloride	3	-	-	-	10	10	-	-
Pendimethalin	0.1	-	-	-	0.1	2500	-	2500
Penflufen	0.01	-	0.01	-	0.01	-	-	-
Pentachloronitrobenzene	-	-	-	-	-	0.01	-	-
Penthiopyrad	40	-	-	-	15	-	-	-
Permethrin	50	-	-	-	30	100	-	-
Phorate	0.5	-	-	-	-	-	-	-
Picoxystrobin	15	-	2	-	10	-	5	-
Pirimicarb	-	-	-	0.3	-	0.3	-	-
Primisulfuron-methyl	0.1	-	-	-	0.1	-	-	-
Prochloraz	-	-	-	40	-	40	-	-
Propachlor	3	-	-	-	1	-	-	-
Propargite	10	-	-	-	10	-	-	-
Propiconazole	12	-	-	-	30	-	-	-
Propineb	-	-	-	-	-	2	-	-
Prosulfuron	0.1	-	0.02	-	0.01	-	0.2	-
Prothioconazole	8	-	5	4	10	15	7	-
Pyraclostrobin	5	-	-	30	17	30	-	-
Pyraflufen-ethyl	0.01	-	-	-	0.01	-	-	-
Pyridate	0.03	-	-	-	0.03	-	-	-
Pyriproxyfen	1.1	-	1.1	-	1.1	-	-	-
Pyroxasulfone	0.09	-	-	-	0.15	-	-	-
Rimsulfuron	0.4	-	-	-	2.5	-	-	-
Sethoxydim	2	-	-	-	2.5	-	-	-
Simazine	0.2	-	-	-	0.25	-	-	-
S-metolachlor	40	-	-	-	40	-	-	-
Spinetoram	3.5	-	1	-	10	-	10	-
Spinosad	2.5	-	1	-	10	5	10	-
Spiromesifen	5	-	-	-	8	-	-	-
Sulfentrazone	0.2	-	-	-	0.3	-	-	-
Tebuconazole	4	-	-	-	3.5	-	-	-
Tefluthrin	0.06	-	-	-	0.06	-	-	-
Tembotrione	0.6	-	-	-	0.45	-	-	-
Terbufos	0.5	-	-	-	0.5	0.2	-	-
Tetraconazole	1.1	-	-	-	1.7	-	-	-
Thiabendazole	0.01	-	-	-	0.01	-	-	-
Thiamethoxam	0.1	-	-	-	0.05	0.05	-	-
Thiencarbazone-methyl	0.04	-	-	-	0.02	-	-	-

Table 17. Tolerances established on Forage, Fodder and Straw of Cereal Grains (continued)
(Data provided by Bryant Christie Inc. on January 6, 2017; note that shading indicates a crop definition, group or subgroup tolerance); MRLs in parentheses are more restrictive than the US MRL.

	Corn, field, forage (ppm)		Corn, field, straw (ppm)		Corn, field, fodder (ppm)		Corn, field, hay (ppm)	
Compound	US	Codex	US	Codex	US	Codex	US	Codex
Thifensulfuron-methyl	0.1	-	-	-	-	-	-	-
Thiodicarb	-	-	-	10	-	10	-	10
Thiram	-	-	-	-	-	2	-	-
Topramezone	0.05	-	-	-	0.05	-	-	-
Triadimefon	-	5	-	-	-	5	-	-
Triadimenol	-	5	-	-	0.05	5	-	-
Tribenuron methyl	-	-	-	-	1.1	-	-	-
Trifloxystrobin	8	-	-	-	7	10	-	-
Trifluralin	0.05	-	-	-	0.05	-	-	-
Triticonazole	0.1	-	0.1	-	0.1	-	-	-
Zeta-cypermethrin	9	-	-	10	30	10	-	-
Zineb	-	-	-	-	-	2	-	-
Ziram	-	-	-	-	-	2	-	-

Table 17. Tolerances established on Forage, Fodder and Straw of Cereal Grains (continued)
(Data provided by Bryant Christie Inc. on January 6, 2017; note that shading indicates a crop definition, group or subgroup tolerance); MRLs in parentheses are more restrictive than the US MRL.

	Corn, sweet, forage (ppm)		Corn, sweet, straw (ppm)		Corn, sweet, fodder (ppm)		Corn, sweet, hay (ppm)	
Compound	US	Codex	US	Codex	US	Codex	US	Codex
2,4-D	6	-	-	-	50	40	-	400
Abamectin	0.2	-	-	-	0.5	-	-	-
Acetamiprid	15	-	-	-	30	40	-	-
Acetochlor	1.5	-	-	-	1	1.5	-	-
Alachlor	-	-	-	-	2	-	-	-
Aldicarb	-	-	-	-	-	0.5	-	-
Alpha-cypermethrin	-	-	-	10	-	10	-	-
Aminocyclopyrachlor	-	-	-	-	-	150	-	150
Aminopyralid	0.3	-	-	0.3	-	3	-	70
Atrazine	15	-	-	-	2	-	-	-
Azoxystrobin	12	40	-	15	25	15	-	-
Benoxacor	0.01	-	-	-	0.01	-	-	-
Bentazon	-	-	-	-	-	0.4	-	2
Benzovindiflupyr	4	-	-	-	5	-	-	-
Beta-cyfluthrin	25	-	7	-	30	-	6	-
Beta-cypermethrin	-	-	-	10	-	10	-	-
Bicyclopyrone	0.4	-	-	-	0.7	-	-	-
Bifenthrin	3	-	-	-	5	15	-	-
Bixafen	4	-	7	-	6	-	5	-
Boscalid	-	-	-	5	-	5	-	-
Captan	0.05	-	0.05	-	0.05	-	-	-
Carbaryl	185	-	-	-	215	250	-	-
Carbon disulfide	-	-	-	-	-	2	-	-
Carboxin	0.2	-	-	-	0.2	-	-	-
Carfentrazone-ethyl	1	-	3	-	0.8	-	0.3	-
Chlorantraniliprole	40	-	40	0.3	40	25	-	-
Chlorethoxyphos	0.01	-	-	-	0.01	-	-	-
Chlormequat	-	-	-	30	-	7	-	-
Chlorpyrifos	8	-	-	-	8	10	-	-
Clopyralid	7	-	-	-	10	-	-	-
Clothianidin	0.35	-	0.05	-	0.1	0.01	0.07	-
Cyantraniliprole	-	-	-	0.2	-	0.2	-	0.2
Cycloxydim	-	-	-	-	-	2	-	-
Cyfluthrin	25	-	7	-	30	-	6	-
Cyhalothrin	-	-	-	2	-	2	-	-
Cypermethrin	-	-	-	10	-	10	-	-
Cyproconazole	-	-	-	5	-	2	-	-
Cyprodinil	-	-	-	10	-	10	-	-
Cyprosulfamide	0.4	-	-	-	0.35	-	-	-

Table 17. Tolerances established on Forage, Fodder and Straw of Cereal Grains (continued)
(Data provided by Bryant Christie Inc. on January 6, 2017; note that shading indicates a crop definition, group or subgroup tolerance); MRLs in parentheses are more restrictive than the US MRL.

	Corn, sweet, forage (ppm)		Corn, sweet, straw (ppm)		Corn, sweet, fodder (ppm)		Corn, sweet, hay (ppm)	
Compound	US	Codex	US	Codex	US	Codex	US	Codex
Deltamethrin	10	-	-	-	15	-	-	-
Dicamba	0.5	-	-	-	0.5	0.6	-	30
Dichlobenil	-	-	-	0.4	-	0.4	-	-
Dichlormid	0.05	-	-	-	0.05	-	-	-
Difenoconazole	0.01	-	-	-	0.01	-	-	-
Diflubenzuron	-	-	-	1.5	-	1.5	-	3
Diflufenzopyr	0.05	-	-	-	0.05	-	-	-
Dimethenamid	0.01	-	-	-	0.01	0.01	-	-
Dimethenamid-p	0.01	-	-	-	0.01	0.01	-	-
Dimethoate	1	-	-	-	-	-	-	-
Diquat dibromide	0.02	-	0.02	-	0.02	-	-	-
Disulfoton	-	-	-	-	-	3	-	-
EPTC	0.08	-	-	-	0.08	-	-	-
Esfenvalerate	15	-	-	-	15	-	-	-
Ethoprop	0.02	-	-	-	0.02	-	-	-
Ferbam	-	-	-	-	-	2	-	-
Fipronil	-	-	-	-	-	0.1	-	-
Flubendiamide	9	-	-	-	25	-	-	-
Fludioxonil	0.01	-	0.01	0.06	0.01	0.06	-	-
Flufenacet	0.45	-	-	-	0.3	-	-	-
Flumioxazin	-	-	-	-	-	0.02	-	-
Fluopicolide	-	-	-	0.2	-	0.2	-	-
Fluopyram	20	-	20	-	20	-	-	-
Fluoxastrobin	13	-	-	-	10	-	-	-
Flupyradifurone	30	-	30	-	30	-	-	-
Fluroxypyr	1	-	-	-	2	-	-	-
Fluroxypyr-meptyl	1	-	12	-	2	-	20	-
Flusilazole	-	-	-	5	-	5	-	-
Fluthiacet-methyl	0.05	-	-	-	0.05	-	-	-
Flutriafol	-	-	-	-	-	20	-	-
Fluxapyroxad	20	-	20	-	20	15	-	-
Gamma cyhalothrin	6	-	-	2	1	2	-	-
Glufosinate-ammonium	1.5	-	-	-	6	8	-	-
Glyphosate	-	-	-	-	-	150	-	500
Halosulfuron-methyl	0.2	-	-	-	0.8	-	-	-
Imazapic-ammonium	-	-	-	-	-	3	-	3
Imazapyr	-	-	-	-	-	6	-	6

Table 17. Tolerances established on Forage, Fodder and Straw of Cereal Grains (continued)
(Data provided by Bryant Christie Inc. on January 6, 2017; note that shading indicates a crop definition, group or subgroup tolerance); MRLs in parentheses are more restrictive than the US MRL.

	Corn, sweet, forage (ppm)		Corn, sweet, straw (ppm)		Corn, sweet, fodder (ppm)		Corn, sweet, hay (ppm)	
Compound	US	Codex	US	Codex	US	Codex	US	Codex
Imidacloprid	7	-	3	-	0.3	0.2	6	-
Indoxacarb	10	-	-	-	15	25	-	-
Ipconazole	0.01	-	0.01	-	0.01	-	-	-
Isoxadifen-ethyl	0.3	-	-	-	0.45	-	-	-
Isoxaflutole	-	-	-	-	-	0.02	-	-
Kresoxim-methyl	-	-	-	5	-	5	-	-
Lambda cyhalothrin	6	-	-	2	1	2	-	-
Lindane	-	-	0.01	-	-	0.01	-	-
Linuron	1	-	-	-	6	-	-	-
Malathion	8	-	-	-	-	-	-	-
Mancozeb	70	-	-	-	40	2	-	-
Maneb	-	-	-	-	-	2	-	-
MCPA	-	-	-	-	-	0.3	-	500
Mesotrione	0.5	-	-	-	1.5	-	-	-
Metaldehyde	0.3	-	-	-	0.1	-	-	-
Metconazole	3	-	-	-	30	-	-	-
Methomyl	10	-	-	10	10	10	-	10
Methoxyfenozide	30	-	-	-	60	60	-	-
Metiram	-	-	-	-	-	2	-	-
Metolachlor	6	-	-	-	6	-	-	-
Metribuzin	0.1	-	-	-	0.1	-	-	-
Myclobutanil	-	-	-	0.3	-	0.3	-	-
Nicosulfuron	0.1	-	-	-	0.1	-	-	-
Nitrapyrin	1	-	-	-	1	-	-	-
Novaluron	16	-	-	-	50	-	-	-
Omethoate	1	-	-	-	-	-	-	-
Oxydemeton-methyl	1	-	-	-	3	-	-	-
Paraquat dichloride	3	-	-	-	10	10	-	-
Pendimethalin	0.1	-	-	-	0.1	2500	-	2500
Penflufen	0.01	-	0.01	-	0.01	-	-	-
Pentachloronitrobenzene	-	-	-	-	-	0.01	-	-
Permethrin	50	-	-	-	30	100	-	-
Phorate	0.5	-	-	-	-	-	-	-
Picoxystrobin	15	-	2	-	10	-	5	-
Pirimicarb	-	-	-	0.3	-	0.3	-	-
Prochloraz	-	-	-	40	-	40	-	-
Propachlor	3	-	-	-	-	-	-	-
Propargite	10	-	-	-	10	-	-	-
Propiconazole	6	-	-	-	30	-	-	-

Table 17. Tolerances established on Forage, Fodder and Straw of Cereal Grains (continued)
(Data provided by Bryant Christie Inc. on January 6, 2017; note that shading indicates a crop definition, group or subgroup tolerance); MRLs in parentheses are more restrictive than the US MRL.

	Corn, sweet, forage (ppm)		Corn, sweet, straw (ppm)		Corn, sweet, fodder (ppm)		Corn, sweet, hay (ppm)	
Compound	US	Codex	US	Codex	US	Codex	US	Codex
Propineb	-	-	-	-	-	2	-	-
Prosulfuron	0.1	-	0.02	-	0.01	-	0.2	-
Prothioconazole	8	-	5	4	10	15	7	-
Pyraclostrobin	5	-	-	30	23	30	-	-
Pyraflufen-ethyl	0.01	-	-	-	0.01	-	-	-
Pyridate	0.03	-	-	-	0.03	-	-	-
Pyriproxyfen	1.1	-	1.1	-	1.1	-	-	-
Pyroxasulfone	0.1	-	-	-	0.15	-	-	-
Saflufenacil	0.1	-	0.1	-	0.1	0.05	-	-
Sedaxane	0.01	-	-	0.1	0.01	0.1	-	0.1
Sethoxydim	3	-	-	-	3.5	-	-	-
Simazine	0.2	-	-	-	0.25	-	-	-
S-metolachlor	40	-	-	-	40	-	-	-
Spinetoram	3.5	-	1	-	10	-	10	-
Spinosad	2.5	-	1	-	10	5	10	-
Spiromesifen	17	-	-	-	12	-	-	-
Tebuconazole	7	-	-	-	6	-	-	-
Tefluthrin	0.06	-	-	-	0.06	-	-	-
Tembotrione	0.35	-	-	-	0.6	-	-	-
Terbufos	0.5	-	-	-	0.5	0.2	-	-
Thiabendazole	0.01	-	-	-	0.01	-	-	-
Thiamethoxam	0.1	-	-	-	0.05	0.05	-	-
Thiencarbazone-methyl	0.05	-	-	-	0.05	-	-	-
Thiodicarb	-	-	-	10	-	10	-	10
Thiram	-	-	-	-	-	2	-	-
Topramezone	0.05	-	-	-	0.05	-	-	-
Triadimefon	-	5	-	-	-	5	-	-
Triadimenol	-	5	-	-	0.05	5	-	-
Trifloxystrobin	7	-	-	-	4	10	-	-
Triticonazole	0.1	-	0.1	-	0.1	-	-	-
Zeta-cypermethrin	15	-	-	10	15	10	-	-
Zineb	-	-	-	-	-	2	-	-
Ziram	-	-	-	-	-	2	-	-

Table 17. Tolerances established on Forage, Fodder and Straw of Cereal Grains (continued)
(Data provided by Bryant Christie Inc. on January 6, 2017; note that shading indicates a crop definition, group or subgroup tolerance); MRLs in parentheses are more restrictive than the US MRL.

	Millet, pearl, forage (ppm)		Millet, pearl, straw (ppm)		Millet, pearl, fodder (ppm)		Millet, pearl, hay (ppm)	
Compound	US	Codex	US	Codex	US	Codex	US	Codex
2,4-D	25	-	50	-	-	400	-	400
Acetochlor	-	-	-	-	-	0.3	-	-
Alpha-cypermethrin	-	-	-	10	-	10	-	-
Aminocyclopyrachlor	-	-	-	-	-	150	-	150
Aminopyralid	-	-	-	0.3	-	3	-	70
Azoxystrobin	-	-	-	15	-	15	-	-
Bentazon	-	-	-	-	-	0.3	-	2
Beta-cyfluthrin	25	-	7	-	30	-	6	-
Beta-cypermethrin	-	-	-	10	-	10	-	-
Boscalid	-	-	-	5	-	5	-	-
Captan	0.05	-	0.05	-	0.05	-	-	-
Carfentrazone-ethyl	1	-	3	-	0.8	-	0.3	-
Chlorantraniliprole	40	-	40	0.3	40	0.3	-	-
Chlormequat	-	-	-	30	-	30	-	-
Clothianidin	0.35	-	0.05	-	0.1	-	0.07	-
Cyantraniliprole	-	-	-	0.2	-	0.2	-	0.2
Cyfluthrin	25	-	7	-	30	-	6	-
Cyhalothrin	-	-	-	2	-	2	-	-
Cypermethrin	-	-	-	10	-	10	-	-
Cyproconazole	-	-	-	5	-	5	-	-
Cyprodinil	-	-	-	10	-	10	-	-
Dicamba	-	-	-	-	-	30	-	30
Dichlobenil	-	-	-	0.4	-	0.4	-	-
Diflubenzuron	-	-	-	1.5	-	1.5	-	3
Diquat dibromide	0.02	-	0.02	-	0.02	-	-	-
Fludioxonil	0.01	-	0.01	0.06	0.01	0.06	-	-
Fluopicolide	-	-	-	0.2	-	0.2	-	-
Fluopyram	20	-	20	-	20	-	-	-
Flupyradifurone	30	-	30	-	30	-	-	-
Fluroxypyr	12	-	-	-	-	-	20	-
Fluroxypyr-meptyl	12	-	-	-	-	-	20	-
Flusilazole	-	-	-	5	-	5	-	-
Fluxapyroxad	20	-	20	-	20	-	-	-
Gamma cyhalothrin	-	-	-	2	-	2	-	-
Glyphosate	100	-	100	-	100	500	-	500
Imazapic-ammonium	-	-	-	-	-	3	-	3
Imazapyr	-	-	-	-	-	6	-	6

Table 17. Tolerances established on Forage, Fodder and Straw of Cereal Grains (continued)
(Data provided by Bryant Christie Inc. on January 6, 2017; note that shading indicates a crop definition, group or subgroup tolerance); MRLs in parentheses are more restrictive than the US MRL.

	Millet, pearl, forage (ppm)		Millet, pearl, straw (ppm)		Millet, pearl, fodder (ppm)		Millet, pearl, hay (ppm)	
Compound	US	Codex	US	Codex	US	Codex	US	Codex
Imidacloprid	7	-	3	-	0.3	-	6	-
Ipconazole	0.01	-	0.01	-	0.01	-	-	-
Kresoxim-methyl	-	-	-	5	-	5	-	-
Lambda cyhalothrin	-	-	-	2	-	2	-	-
Lindane	-	-	-	0.01	-	0.01	-	-
MCPA	-	-	-	-	-	500	-	500
Mesotrione	0.01	-	0.02	-	-	-	0.02	-
Methomyl	-	-	-	10	-	10	-	10
Myclobutanil	-	-	-	0.3	-	0.3	-	-
Penflufen	0.01	-	0.01	-	0.01	-	-	-
Penthiopyrad	-	-	-	-	-	10	-	-
Picoxystrobin	15	-	2	-	10	-	5	-
Pirimicarb	-	-	-	0.3	-	0.3	-	-
Prochloraz	-	-	-	40	-	40	-	-
Prosulfuron	0.1	-	0.02	-	0.01	-	0.2	-
Prothioconazole	8	-	5	4	10	5	7	-
Pyraclostrobin	-	-	-	30	-	30	-	-
Pyriproxyfen	1.1	-	1.1	-	1.1	-	-	-
Saflufenacil	0.1	-	0.1	-	0.1	-	-	-
Sedaxane	-	-	-	0.1	-	0.1	-	0.1
Spinetoram	3.5	-	1	-	10	-	10	-
Spinosad	2.5	-	1	-	10	-	10	-
Thiamethoxam	0.02	-	-	-	0.02	-	-	-
Thiodicarb	-	-	-	10	-	10	-	10
Triadimefon	-	-	-	5	-	5	-	-
Triadimenol	-	-	-	5	-	5	-	-
Triticonazole	0.1	-	0.1	-	0.1	-	-	-
Zeta-cypermethrin	-	-	-	10	-	10	-	-

Table 17. Tolerances established on Forage, Fodder and Straw of Cereal Grains (continued)
(Data provided by Bryant Christie Inc. on January 6, 2017; note that shading indicates a crop definition, group or subgroup tolerance); MRLs in parentheses are more restrictive than the US MRL.

	Millet, proso, forage (ppm)		Millet, proso, straw (ppm)		Millet, proso, fodder (ppm)		Millet, proso, hay (ppm)	
Compound	US	Codex	US	Codex	US	Codex	US	Codex
2,4-D	25	-	50	-	-	400	-	400
Acetochlor	-	-	-	-	-	0.3	-	-
Alpha-cypermethrin	-	-	-	10	-	10	-	-
Aminocyclopyrachlor	-	-	-	-	-	150	-	150
Aminopyralid	-	-	-	0.3	-	3	-	70
Azoxystrobin	-	-	-	15	-	15	-	-
Bentazon	-	-	-	-	-	0.3	-	2
Beta-cyfluthrin	25	-	7	-	30	-	6	-
Beta-cypermethrin	-	-	-	10	-	10	-	-
Boscalid	-	-	-	5	-	5	-	-
Captan	0.05	-	0.05	-	0.05	-	-	-
Carfentrazone-ethyl	1	-	3	-	0.8	-	0.3	-
Chlorantraniliprole	40	-	40	0.3	40	0.3	-	-
Chlormequat	-	-	-	30	-	30	-	-
Clothianidin	0.35	-	0.05	-	0.1	-	0.07	-
Cyantraniliprole	-	-	-	0.2	-	0.2	-	0.2
Cyfluthrin	25	-	7	-	30	-	6	-
Cyhalothrin	-	-	-	2	-	2	-	-
Cypermethrin	-	-	-	10	-	10	-	-
Cyproconazole	-	-	-	5	-	5	-	-
Cyprodinil	-	-	-	10	-	10	-	-
Dicamba	90	-	-	-	-	30	40	30
Dichlobenil	-	-	-	0.4	-	0.4	-	-
Diflubenzuron	-	-	-	1.5	-	1.5	-	3
Diquat dibromide	0.02	-	0.02	-	0.02	-	-	-
Fludioxonil	0.01	-	0.01	0.06	0.01	0.06	-	-
Fluopicolide	-	-	-	0.2	-	0.2	-	-
Fluopyram	20	-	20	-	20	-	-	-
Flupyradifurone	30	-	30	-	30	-	-	-
Fluroxypyr	12	-	-	-	-	-	20	-
Fluroxypyr-meptyl	12	-	-	-	-	-	20	-
Flusilazole	-	-	-	5	-	5	-	-
Fluxapyroxad	20	-	20	-	20	-	-	-
Gamma cyhalothrin	-	-	-	2	-	2	-	-
Glyphosate	100	-	100	-	100	500	-	500
Halosulfuron-methyl	10	-	-	-	-	-	0.01	-
Imazapic-ammonium	-	-	-	-	-	3	-	3
Imazapyr	-	-	-	-	-	6	-	6

Table 17. Tolerances established on Forage, Fodder and Straw of Cereal Grains (continued)
(Data provided by Bryant Christie Inc. on January 6, 2017; note that shading indicates a crop definition, group or subgroup tolerance); MRLs in parentheses are more restrictive than the US MRL.

	Millet, proso, forage (ppm)		Millet, proso, straw (ppm)		Millet, proso, fodder (ppm)		Millet, proso, hay (ppm)	
Compound	US	Codex	US	Codex	US	Codex	US	Codex
Imidacloprid	7	-	3	-	0.3	-	6	-
Ipconazole	0.01	-	0.01	-	0.01	-	-	-
Kresoxim-methyl	-	-	-	5	-	5	-	-
Lambda cyhalothrin	-	-	-	2	-	2	-	-
Lindane	-	-	-	0.01	-	0.01	-	-
MCPA	-	-	-	-	-	500	-	500
Mesotrione	0.01	-	0.02	-	-	-	0.02	-
Methomyl	-	-	-	10	-	10	-	10
Myclobutanil	-	-	-	0.3	-	0.3	-	-
Pendimethalin	-	-	-	-	-	2500	-	2500
Penflufen	0.01	-	0.01	-	0.01	-	-	-
Penthiopyrad	-	-	-	-	-	10	-	-
Picoxystrobin	15	-	2	-	10	-	5	-
Pirimicarb	-	-	-	0.3	-	0.3	-	-
Prochloraz	-	-	-	40	-	40	-	-
Prosulfuron	0.1	-	0.02	-	0.01	-	0.2	-
Prothioconazole	8	-	5	4	10	5	7	-
Pyraclostrobin	-	-	-	30	-	30	-	-
Pyriproxyfen	1.1	-	1.1	-	1.1	-	-	-
Saflufenacil	0.1	-	0.1	-	0.1	30	-	30
Sedaxane	-	-	-	0.1	-	0.1	-	0.1
Spinetoram	3.5	-	1	-	10	-	10	-
Spinosad	2.5	-	1	-	10	-	10	-
Thiamethoxam	0.02	-	-	-	0.02	-	-	-
Thiodicarb	-	-	-	10	-	10	-	10
Triadimefon	-	-	-	5	-	5	-	-
Triadimenol	-	-	-	5	-	5	-	-
Triticonazole	0.1	-	0.1	-	0.1	-	-	-
Zeta-cypermethrin	-	-	-	10	-	10	-	-

Table 17. Tolerances established on Forage, Fodder and Straw of Cereal Grains (continued)
(Data provided by Bryant Christie Inc. on January 6, 2017; note that shading indicates a crop definition, group or subgroup tolerance); MRLs in parentheses are more restrictive than the US MRL.

	Oat, forage (ppm)		Oat, straw (ppm)		Oat, fodder (ppm)		Oat, hay (ppm)	
Compound	US	Codex	US	Codex	US	Codex	US	Codex
2,4-D	25	-	50	-	-	400	-	400
Acetochlor	-	-	-	0.3	-	0.3	-	-
Alpha-cypermethrin	-	-	-	10	-	10	-	-
Aminocyclopyrachlor	-	-	-	-	-	150	-	150
Aminopyralid	-	-	-	0.3	-	3	-	70
Azoxystrobin	5	-	3	15	-	15	10	-
Bentazon	-	-	-	0.3	-	0.3	-	2
Benzovindiflupyr	-	-	15	-	-	-	15	-
Beta-cyfluthrin	25	-	7	-	30	-	6	-
Beta-cypermethrin	-	-	-	10	-	10	-	-
Bitertanol	-	-	-	0.05	-	0.05	-	-
Boscalid	-	-	-	50	-	50	-	-
Bromoxynil	0.3	-	4	-	-	-	9	-
Captan	0.05	-	0.05	-	0.05	-	-	-
Carboxin	0.5	-	0.2	-	-	-	-	-
Carfentrazone-ethyl	1	-	3	-	0.8	-	0.3	-
Chlorantraniliprole	40	-	40	0.3	40	0.3	-	-
Chlormequat	-	-	-	30	-	30	-	-
Chlorsulfuron	20	-	0.5	-	-	-	-	-
Clopyralid	9	-	9	-	-	-	-	-
Clothianidin	0.35	-	0.05	-	0.1	-	0.07	-
Cyantraniliprole	-	-	-	0.2	-	0.2	-	0.2
Cyfluthrin	25	-	7	-	30	-	6	-
Cyhalothrin	-	-	-	2	-	2	-	-
Cypermethrin	-	-	-	10	-	10	-	-
Cyproconazole	-	-	-	5	-	5	-	-
Cyprodinil	-	-	-	10	-	10	-	-
Dicamba	90	-	30	-	-	30	40	30
Dichlobenil	-	-	-	0.4	-	0.4	-	-
Difenoconazole	0.15	-	0.05	-	-	-	0.05	-
Diflubenzuron	7	-	3.5	1.5	-	1.5	6	3
Diquat dibromide	0.02	-	0.02	-	0.02	-	-	-
Disulfoton	-	-	-	0.05	-	0.05	-	-
Fenpropimorph	-	-	-	5	-	5	-	-
Florasulam	0.05	-	0.05	-	-	-	0.05	-
Fludioxonil	0.01	-	0.01	0.06	0.01	0.06	-	-
Fluopicolide	-	-	-	0.2	-	0.2	-	-
Fluopyram	20	-	20	-	20	-	-	-

Table 17. Tolerances established on Forage, Fodder and Straw of Cereal Grains (continued)
(Data provided by Bryant Christie Inc. on January 6, 2017; note that shading indicates a crop definition, group or subgroup tolerance); MRLs in parentheses are more restrictive than the US MRL.

	Oat, forage (ppm)		Oat, straw (ppm)		Oat, fodder (ppm)		Oat, hay (ppm)	
Compound	US	Codex	US	Codex	US	Codex	US	Codex
Flupyradifurone	30	-	30	-	30	-	-	-
Fluroxypyr	12	-	12	-	-	-	20	-
Fluroxypyr-meptyl	12	-	12	-	-	-	20	-
Fluxapyroxad	20	-	20	30	20	30	-	-
Gamma cyhalothrin	-	-	-	2	-	2	-	-
Glyphosate	-	-	-	100	100	100	-	500
Imazapic-ammonium	-	-	-	-	-	3	-	3
Imazapyr	-	-	-	-	-	6	-	6
Imidacloprid	7	-	3	1	0.3	1	6	-
Ipconazole	0.01	-	0.01	-	0.01	-	-	-
Kresoxim-methyl	-	-	-	5	-	5	-	-
Lambda cyhalothrin	2	-	2	2	-	2	2	-
Lindane	-	-	-	0.01	-	0.01	-	-
Malathion	4	-	50	-	-	-	-	-
Mancozeb	-	-	25	-	-	-	30	-
MCPA	20	-	25	50	-	50	115	500
Mesotrione	0.01	-	0.01	-	-	-	0.01	-
Metconazole	-	-	6	-	-	-	17	-
Methomyl	10	-	10	10	-	10	10	10
Metrafenone	-	-	-	6	-	6	-	-
Myclobutanil	-	-	-	0.3	-	0.3	-	-
Penflufen	0.01	-	0.01	-	0.01	-	-	-
Penthiopyrad	40	-	1	80	-	80	80	-
Picloram	1	-	1	-	-	-	-	-
Picoxystrobin	15	-	2	-	10	-	5	-
Pirimicarb	-	-	-	0.3	-	0.3	-	-
Prochloraz	-	-	-	40	-	40	-	-
Propiconazole	4	-	10	8	-	8	15	-
Prosulfuron	0.1	-	0.02	-	0.01	-	0.2	-
Prothioconazole	8	-	5	4	10	5	7	-
Pyraclostrobin	-	-	15	30	-	30	18	-
Pyrasulfotole	0.1	-	0.2	-	-	-	0.5	-
Pyriproxyfen	1.1	-	1.1	-	1.1	-	-	-
Saflufenacil	0.1	-	0.1	-	0.1	-	-	-
Sedaxane	0.015	-	0.01	0.1	-	0.1	0.06	0.1
Spinetoram	3.5	-	1	-	10	-	10	-
Spinosad	2.5	-	1	-	10	-	10	-

Table 17. Tolerances established on Forage, Fodder and Straw of Cereal Grains (continued)
(Data provided by Bryant Christie Inc. on January 6, 2017; note that shading indicates a crop definition, group or subgroup tolerance); MRLs in parentheses are more restrictive than the US MRL.

	Oat, forage (ppm)		Oat, straw (ppm)		Oat, fodder (ppm)		Oat, hay (ppm)	
Compound	US	Codex	US	Codex	US	Codex	US	Codex
2-(Thiocyanomethylthio)benzothiazole	0.1	-	0.1	-	-	-	0.1	-
Tebuconazole	0.1	-	0.1	-	-	-	0.1	-
Thiabendazole	0.3	-	0.3	-	-	-	0.3	-
Thiamethoxam	0.5	-	0.02	-	-	-	0.02	-
Thifensulfuron-methyl	0.2	-	0.1	-	-	-	0.05	-
Thiodicarb	-	-	-	10	-	10	-	10
Triadimefon	-	-	-	5	-	5	-	-
Triadimenol	2.5	-	0.2	5	-	5	-	-
Tribenuron methyl	0.05	-	0.1	-	-	-	0.05	-
Trifloxystrobin	0.3	-	5	-	-	-	0.3	-
Trinexapac-ethyl	1	-	0.9	0.9	-	0.9	1.5	-
Triticonazole	0.1	-	0.1	-	0.1	-	-	-
Zeta-cypermethrin	-	-	20	10	-	10	6	-

Table 17. Tolerances established on Forage, Fodder and Straw of Cereal Grains (continued)
(Data provided by Bryant Christie Inc. on January 6, 2017; note that shading indicates a crop definition, group or subgroup tolerance); MRLs in parentheses are more restrictive than the US MRL.

	Corn, pop, straw (ppm)		Corn, pop, fodder (ppm)		Corn, pop, hay (ppm)		Corn, pop, forage (ppm)	
Compound	US	Codex	US	Codex	US	Codex	US	Codex
2,4-D	-	-	50	400	-	400	-	-
Acetochlor	-	-	2.5	-	-	-	-	-
4-(Dichloroacetyl)-1-oxa-4-azaspiro[4.5]decane	-	-	0.005	-	-	-	-	-
Alachlor	-	-	2	-	-	-	-	-
Alpha-cypermethrin	-	10	-	10	-	-	-	-
Aluminum phosphide	-	-	-	-	-	-	-	-
Ametryn	-	-	0.05	-	-	-	-	-
Aminocyclopyrachlor	-	-	-	150	-	150	-	-
Aminopyralid	-	0.3	-	3	-	70	-	-
Atrazine	-	-	0.5	-	-	-	1.5	-
Azoxystrobin	-	15	25	15	-	-	-	-
Benoxacor	-	-	0.01	-	-	-	-	-
Bentazon	-	-	-	2	-	2	-	-
Benzovindiflupyr	-	-	15	-	-	-	-	-
Beta-cyfluthrin	7	-	30	-	6	-	25	-
Beta-cypermethrin	-	10	-	10	-	-	-	-
Bicyclopyrone	-	-	0.4	-	-	-	-	-
Bifenthrin	-	-	5	-	-	-	-	-
Boscalid	-	5	-	5	-	-	-	-
Bromoxynil	-	-	0.2	-	-	-	-	-
Captan	0.05	-	0.05	-	-	-	0.05	-
Carbaryl	-	-	20	-	-	-	-	-
Carboxin	-	-	0.2	-	-	-	-	-
Carfentrazone-ethyl	3	-	0.8	-	0.3	-	1	-
Chlorantraniliprole	40	0.3	40	0.3	-	-	40	-
Chlorethoxyphos	-	-	0.01	-	-	-	-	-
Chlormequat	-	30	-	30	-	-	-	-
Clopyralid	-	-	10	-	-	-	-	-
Clothianidin	0.05	-	0.1	-	0.07	-	0.35	-
Cyantraniliprole	-	0.2	-	0.2	-	0.2	-	-
Cyfluthrin	7	-	30	-	6	-	25	-
Cyhalothrin	-	2	-	2	-	-	-	-
Cypermethrin	-	10	-	10	-	-	-	-
Cyproconazole	-	5	-	5	-	-	-	-
Cyprodinil	-	10	-	10	-	-	-	-
Cyprosulfamide	-	-	0.2	-	-	-	-	-
Deltamethrin	-	-	5	-	-	-	-	-
Dicamba	-	-	3	30	-	30	-	-
Dichlobenil	-	0.4	-	0.4	-	-	-	-

Table 17. Tolerances established on Forage, Fodder and Straw of Cereal Grains (continued)
(Data provided by Bryant Christie Inc. on January 6, 2017; note that shading indicates a crop definition, group or subgroup tolerance); MRLs in parentheses are more restrictive than the US MRL.

	Corn, pop, straw (ppm)		Corn, pop, fodder (ppm)		Corn, pop, hay (ppm)		Corn, pop, forage (ppm)	
Compound	US	Codex	US	Codex	US	Codex	US	Codex
Dichlormid	-	-	0.05	-	-	-	-	-
Diflubenzuron	-	1.5	-	1.5	-	-	-	-
Diflufenzopyr	-	-	0.05	3	-	3	-	-
Dimethenamid	-	-	0.01	-	-	-	0.01	-
Dimethenamid-p	-	-	0.01	-	-	-	0.01	-
Dimethoate	-	-	1	-	-	-	-	-
Diquat dibromide	0.02	-	0.02	-	-	-	0.02	-
Diuron	-	-	-	-	-	-	-	-
EPTC	-	-	0.08	-	-	-	-	-
Esfenvalerate	-	-	15	-	-	-	-	-
Etoxazole	-	-	4	-	-	-	-	-
Fenpyroximate	-	-	7	-	-	-	2	-
Flubendiamide	-	-	15	-	-	-	-	-
Fludioxonil	0.01	0.06	0.01	0.06	-	-	0.01	-
Fluopicolide	-	0.2	-	0.2	-	-	-	-
Fluopyram	20	-	20	-	-	-	20	-
Fluoride	-	-	-	-	-	-	-	-
Flupyradifurone	30	-	30	-	-	-	30	-
Flusilazole	-	5	-	5	-	-	-	-
Fluthiacet-methyl	-	-	0.05	-	-	-	-	-
Flutriafol	-	-	15	-	-	-	-	-
Fluxapyroxad	20	-	20	-	-	-	20	-
Furilazole	-	-	0.01	-	-	-	-	-
Gamma cyhalothrin	-	2	1	2	-	-	-	-
Glyphosate	-	-	100	500	-	500	-	-
Halosulfuron-methyl	-	-	0.8	-	-	-	-	-
Imazapic-ammonium	-	-	-	3	-	3	-	-
Imazapyr	-	-	-	6	-	6	-	-
Imidacloprid	3	-	0.3	-	6	-	7	-
Ipconazole	0.01	-	0.01	-	-	-	0.01	-
Isoxadifen-ethyl	-	-	0.25	-	-	-	-	-
Kresoxim-methyl	-	5	-	5	-	-	-	-
Lambda cyhalothrin	-	2	1	2	-	-	-	-
Lindane	-	0.01	-	0.01	-	-	-	-
Magnesium phosphide	-	-	-	-	-	-	-	-
Malathion	-	-	-	-	-	-	-	-
Mancozeb	-	-	40	-	-	-	-	-
MCPA	-	-	-	500	-	500	-	-

Table 17. Tolerances established on Forage, Fodder and Straw of Cereal Grains (continued)
(Data provided by Bryant Christie Inc. on January 6, 2017; note that shading indicates a crop definition, group or subgroup tolerance); MRLs in parentheses are more restrictive than the US MRL.

	Corn, pop, straw (ppm)		Corn, pop, fodder (ppm)		Corn, pop, hay (ppm)		Corn, pop, forage (ppm)	
Compound	US	Codex	US	Codex	US	Codex	US	Codex
Mesotrione	-	-	0.01	-	-	-	-	-
Metconazole	-	-	30	-	-	-	-	-
Methomyl	-	10	10	10	-	10		-
Methoxyfenozide	-	-	125	-	-	-	-	-
Metolachlor	-	-	6	-	-	-	-	-
Metribuzin	-	-	-	-	-	-	-	-
Myclobutanil	-	0.3	-	0.3	-	-	-	-
Nicosulfuron	-	-	0.1	-	-	-	-	-
Nitrapyrin	-	-	1	-	-	-	-	-
Omethoate	-	-	1	-	-	-	-	-
Paraquat dichloride	-	-	10	-	-	-	-	-
Pendimethalin	-	-	-	-	-	-	-	-
Penflufen	0.01	-	0.01	-	-	-	0.01	-
Penthiopyrad	-	-	-	-	-	-	-	-
Permethrin	-	-	30	-	-	-	-	-
Phosphine	-	-	-	-	-	-	-	-
Picoxystrobin	2	-	10	-	5	-	15	-
Pirimicarb	-	0.3	-	0.3	-	-	-	-
Pirimiphos-methyl	-	-	-	-	-	-	-	-
Primisulfuron-methyl	-	-	0.1	-	-	-	-	-
Prochloraz	-	40	-	40	-	-	-	-
Propargite	-	-	10	-	-	-	-	-
Propiconazole	-	-	30	-	-	-	-	-
Prosulfuron	0.02	-	0.01	-	0.2	-	0.1	-
Prothioconazole	5	4	10	5	7	-	8	-
Pyraclostrobin	-	30	17	30	-	-	-	-
Pyrethrins	-	-	-	-	-	-	-	-
Pyridate	-	-	0.03	-	-	-	-	-
Pyriproxyfen	-	-	-	-	-	-	-	-
Pyroxasulfone	1.1	-	0.15	-	-	-	1.1	-
Saflufenacil	0.1	-	0.1	30	-	30	0.1	-
Sedaxane	-	0.1	0.01	0.1	-	0.1	-	-
Simazine	-	-	0.25	-	-	-	-	-
S-metolachlor	-	-	40	-	-	-	-	-
Spinetoram	1	-	10	-	10	-	3.5	-
Spinosad	1	-	10	-	10	-	2.5	-
Spiromesifen	-	-	4	-	-	-	-	-
Sulfuryl fluoride	-	-	-	-	-	-	-	-

Table 17. Tolerances established on Forage, Fodder and Straw of Cereal Grains (continued)
(Data provided by Bryant Christie Inc. on January 6, 2017; note that shading indicates a crop definition, group or subgroup tolerance); MRLs in parentheses are more restrictive than the US MRL.

	Corn, pop, straw (ppm)		Corn, pop, fodder (ppm)		Corn, pop, hay (ppm)		Corn, pop, forage (ppm)	
Compound	US	Codex	US	Codex	US	Codex	US	Codex
2-(Thiocyanomethylthio)benzothiazole	-	-	0.1	-	-	-	-	-
Tebuconazole	-	-	3.5	-	-	-	-	-
Tefluthrin	-	-	0.06	-	-	-	-	-
Tembotrione	-	-	0.35	-	-	-	-	-
Terbufos	-	-	0.5	-	-	-	-	-
Tetraconazole	-	-	1.7	-	-	-	-	-
Thiabendazole	-	-	0.01	-	-	-	0.01	-
Thiamethoxam	-	-	0.05	-	-	-	0.1	-
Thiencarbazone-methyl	-	-	0.01	-	-	-	-	-
Thiodicarb	-	10	-	10	-	10	-	-
Topramezone	-	-	0.05	-	-	-	-	-
Triadimefon	-	5	-	5	-	-	-	-
Triadimenol	-	5	0.05	5	-	-	-	-
Trifloxystrobin	-	-	7	-	-	-	-	-
Triticonazole	0.1	-	0.1	-	-	-	0.1	-
Zeta-cypermethrin	-	10	30	10	-	-	-	-

Table 17. Tolerances established on Forage, Fodder and Straw of Cereal Grains (continued)
(Data provided by Bryant Christie Inc. on January 6, 2017; note that shading indicates a crop definition, group or subgroup tolerance); MRLs in parentheses are more restrictive than the US MRL.

	Rice, forage (ppm)		Rice, straw (ppm)		Rice, fodder (ppm)		Rice, hay (ppm)	
Compound	US	Codex	US	Codex	US	Codex	US	Codex
2,4-D	-	-	-	10	-	10	-	400
Abamectin	-	-	-	0.001	-	0.001	-	-
Acephate	-	-	-	0.3	-	0.3	-	-
Alpha-cypermethrin	-	-	-	10	-	10	-	-
Aminocyclopyrachlor	-	-	-	-	-	150	-	150
Aminopyralid	-	-	-	0.3	-	3	-	70
Azoxystrobin	-	-	-	15	-	15	-	-
Benomyl	-	-	-	15	-	15	-	-
Bentazon	-	-	-	-	-	2	-	2
Beta-cypermethrin	-	-	-	10	-	10	-	-
Boscalid	-	-	-	5	-	5	-	-
Captan	0.05	-	0.05	-	0.05	-	-	-
Carbaryl	-	-	-	120	-	120	-	-
Carbendazim	-	-	-	15	-	15	-	-
Carbofuran	-	-	-	1	-	1	-	-
Carbosulfan	-	-	-	0.05	-	0.05	-	-
Carfentrazone-ethyl	1	-	3	-	0.8	-	0.3	-
Chlorantraniliprole	40	-	40	0.3	40	0.3	-	-
Chlormequat	-	-	-	30	-	30	-	-
Cyantraniliprole	-	-	-	0.2	-	0.2	-	0.2
Cycloxydim	-	-	-	0.09	-	0.09	-	-
Cyhalothrin	-	-	-	2	-	2	-	-
Cypermethrin	-	-	-	10	-	10	-	-
Cyproconazole	-	-	-	5	-	5	-	-
Cyprodinil	-	-	-	10	-	10	-	-
Dicamba	-	-	-	-	-	30	-	30
Dichlobenil	-	-	-	0.4	-	0.4	-	-
Diflubenzuron	-	-	0.8	0.7	-	0.7	-	3
Dinotefuran	-	-	-	6	-	6	-	-
Diquat dibromide	0.02	-	0.02	-	0.02	-	-	-
Etofenprox	-	-	-	0.05	-	0.05	-	-
Fipronil	-	-	-	0.2	-	0.2	-	-
Fludioxonil	0.01	-	0.01	0.06	0.01	0.06	-	-
Fluopicolide	-	-	-	0.2	-	0.2	-	-
Fluopyram	20	-	20	-	20	-	-	-
Flupyradifurone	30	-	30	-	30	-	-	-
Flusilazole	-	-	-	5	-	5	-	-
Flutolanil	-	-	-	10	-	10	-	-

Table 17. Tolerances established on Forage, Fodder and Straw of Cereal Grains (continued)
(Data provided by Bryant Christie Inc. on January 6, 2017; note that shading indicates a crop definition, group or subgroup tolerance); MRLs in parentheses are more restrictive than the US MRL.

	Rice, forage (ppm)		Rice, straw (ppm)		Rice, fodder (ppm)		Rice, hay (ppm)	
Compound	US	Codex	US	Codex	US	Codex	US	Codex
Fluxapyroxad	20	-	20	50	20	50	-	-
Gamma cyhalothrin	-	-	-	2	-	2	-	-
Glufosinate-ammonium	-	-	-	2	-	2	-	-
Glyphosate	-	-	-	-	100	500	-	500
Imazamox	-	-	-	0.01	-	0.01	-	-
Imazapic-ammonium	-	-	-	-	-	3	-	3
Imazapyr	-	-	-	-	-	6	-	6
Kresoxim-methyl	-	-	-	5	-	5	-	-
Lambda cyhalothrin	-	-	-	2	-	2	-	-
Lindane	-	-	-	0.01	-	0.01	-	-
MCPA	-	-	-	-	-	500	-	500
Methamidophos	-	-	-	0.1	-	0.1	-	-
Methomyl	-	-	-	10	-	10	-	10
Myclobutanil	-	-	-	0.3	-	0.3	-	-
Paraquat dichloride	-	-	-	0.05	-	0.05	-	-
Penflufen	0.01	-	0.01	-	0.01	-	-	-
Picoxystrobin	15	-	2	-	10	-	5	-
Pirimicarb	-	-	-	0.3	-	0.3	-	-
Prochloraz	-	-	-	40	-	40	-	-
Prothioconazole	-	5	5	4	-	5	-	-
Pyraclostrobin	-	-	-	30	-	30	-	-
Pyriproxyfen	1.1	-	1.1	-	1.1	-	-	-
Saflufenacil	0.1	-	0.1	-	0.1	-	-	-
Sedaxane	0.1	-	0.1	-	-	-	-	0.1
Spinetoram	3.5	-	-	-	10	-	10	-
Thiodicarb	-	-	-	10	-	10	-	10
Thiophanate-methyl	-	-	-	15	-	15	-	-
Triadimefon	-	-	-	5	-	5	-	-
Triadimenol	-	-	-	5	-	5	-	-
Trifloxystrobin	-	-	-	10	-	10	-	-
Trinexapac-ethyl	-	-	0.07	-	-	-	-	-
Zeta-cypermethrin	-	-	-	10	-	10	-	-

Table 17. Tolerances established on Forage, Fodder and Straw of Cereal Grains (continued)
(Data provided by Bryant Christie Inc. on January 6, 2017; note that shading indicates a crop definition, group or subgroup tolerance); MRLs in parentheses are more restrictive than the US MRL.

	Rye, forage (ppm)		Rye, straw (ppm)		Rye, fodder (ppm)		Rye, hay (ppm)	
Compound	US	Codex	US	Codex	US	Codex	US	Codex
2,4-D	25	-	50	-	-	-	-	400
Acetochlor	-	-	-	0.3	-	0.3	-	-
Alpha-cypermethrin	-	-	-	10	-	10	-	-
Aminocyclopyrachlor	-	-	-	-	-	150	-	150
Aminopyralid	-	-	-	0.3	-	3	-	70
Azoxystrobin	7	-	1.5	15	-	15	-	-
Bentazon	-	-	-	0.3	-	0.3	-	2
Benzovindiflupyr	-	-	15	-	-	-	15	-
Beta-cyfluthrin	25	-	7	-	30	-	6	-
Beta-cypermethrin	-	-	-	10	-	10	-	-
Bitertanol	-	-	-	0.05	-	0.05	-	-
Boscalid	-	-	-	50	-	50	-	-
Bromoxynil	1	-	2	-	-	-	-	-
Captan	0.05	-	-	-	-	-	-	-
Carfentrazone-ethyl	1	-	3	-	0.8	-	0.3	-
Chlorantraniliprole	40	-	40	0.3	40	0.3	-	-
Chlormequat	-	-	-	30	-	30	-	-
Clothianidin	0.35	-	0.05	-	0.1	-	0.07	-
Cyantraniliprole	-	-	0.2	-	0.2	-	-	0.2
Cyfluthrin	25	-	7	-	30	-	6	-
Cyhalothrin	-	-	-	2	-	2	-	-
Cypermethrin	-	-	-	10	-	10	-	-
Cyproconazole	-	-	-	5	-	5	-	-
Cyprodinil	-	-	-	10	-	10	-	-
Dicamba	90	-	30	-	-	30	-	30
Dichlobenil	-	-	-	0.4	-	0.4	-	-
Difenoconazole	0.15	-	0.05	-	-	-	-	-
Diflubenzuron	-	-	-	1.5	-	1.5	-	3
Diquat dibromide	0.02	-	0.02	-	0.02	-	-	-
Etofenprox	-	-	-	7	-	7	-	-
Fenpropimorph	-	-	-	5	-	5	-	-
Florasulam	0.05	-	0.05	-	-	-	-	-
Fludioxonil	0.01	-	0.01	0.06	0.01	0.06	-	-
Fluopicolide	-	-	-	0.2	-	0.2	-	-
Fluopyram	20	-	20	-	20	-	-	-
Flupyradifurone	30	-	30	-	30	-	-	-
Flusilazole	-	-	-	5	-	5	-	-
Fluxapyroxad	20	-	20	30	20	30	-	-

Table 17. Tolerances established on Forage, Fodder and Straw of Cereal Grains (continued)
(Data provided by Bryant Christie Inc. on January 6, 2017; note that shading indicates a crop definition, group or subgroup tolerance); MRLs in parentheses are more restrictive than the US MRL.

	Rye, forage (ppm)		Rye, straw (ppm)		Rye, fodder (ppm)		Rye, hay (ppm)	
Compound	US	Codex	US	Codex	US	Codex	US	Codex
Gamma cyhalothrin	-	-	-	2	-	2	-	-
Glyphosate	-	-	-	-	100	500	-	500
Imazapic-ammonium	-	-	-	-	-	3	-	3
Imazapyr	-	-	-	-	-	6	-	6
Imidacloprid	7	-	3	1	0.3	1	6	-
Ipconazole	0.01	-	0.01	-	0.01	-	-	-
Isopyrazam	-	-	-	3	-	3	-	-
Kresoxim-methyl	-	-	-	5	-	5	-	-
Lambda cyhalothrin	2	-	2	2	-	2	-	-
Lindane	-	-	-	0.01	-	0.01	-	-
Malathion	4	-	50	-	-	-	-	-
Mancozeb	-	-	25	-	-	-	-	-
MCPA	20	-	25	50	-	50	-	500
Metconazole	-	-	14	-	-	-	-	-
Methomyl	10	-	10	10	-	10	-	10
Metrafenone	-	-	-	10	-	10	-	-
Myclobutanil	-	-	-	0.3	-	0.3	-	-
Oxydemeton-methyl	-	-	-	0.1	-	0.1	-	-
Pendimethalin	-	-	-	-	-	2500	-	2500
Penflufen	0.01	-	0.01	-	0.01	-	-	-
Penthiopyrad	40	-	1	80	-	80	-	-
Picoxystrobin	15	-	2	-	10	-	5	-
Pirimicarb	-	-	-	0.3	-	0.3	-	-
Prochloraz	-	-	-	40	-	40	-	-
Propiconazole	9	-	10	15	-	15	-	-
Prosulfuron	0.1	-	0.02	-	0.01	-	0.2	-
Prothioconazole	8	-	5	4	10	5	7	-
Pyraclostrobin	-	-	0.5	30	-	30	-	-
Pyrasulfotole	0.2	-	0.2	-	-	-	-	-
Pyriproxyfen	1.1	-	1.1	-	1.1	-	-	-
Saflufenacil	0.1	-	0.1	-	0.1	-	-	-
Sedaxane	0.015	-	0.01	0.1	-	0.1	-	0.1
Spinetoram	3.5	-	1	-	10	-	10	-
Spinosad	2.5	-	1	-	10	-	10	-
Tebuconazole	-	-	-	40	-	40	-	-
Thiabendazole	0.3	-	0.3	-	-	-	-	-
Thiamethoxam	0.5	-	0.02	-	-	-	-	-
Thiodicarb	-	-	-	10	-	10	-	10

Table 17. Tolerances established on Forage, Fodder and Straw of Cereal Grains (continued)
(Data provided by Bryant Christie Inc. on January 6, 2017; note that shading indicates a crop definition, group or subgroup tolerance); MRLs in parentheses are more restrictive than the US MRL.

	Rye, forage (ppm)		Rye, straw (ppm)		Rye, fodder (ppm)		Rye, hay (ppm)	
Compound	US	Codex	US	Codex	US	Codex	US	Codex
Triadimefon	-	-	-	5	-	5	-	-
Triadimenol	2.5	-	0.1	5	-	5	-	-
Trinexapac-ethyl	-	-	0.9	-	-	-	1.5	-
Triticonazole	0.1	-	0.1	-	0.1	-	-	-
Zeta-cypermethrin	-	-	20	10	-	10	6	-

Table 17. Tolerances established on Forage, Fodder and Straw of Cereal Grains (continued)
(Data provided by Bryant Christie Inc. on January 6, 2017; note that shading indicates a crop definition, group or subgroup tolerance); MRLs in parentheses are more restrictive than the US MRL.

	Sorghum, straw (ppm)		Sorghum, fodder (ppm)		Sorghum, hay (ppm)		Sorghum, forage (ppm)	
Compound	US	Codex	US	Codex	US	Codex	US	Codex
2,4-D	-	-	0.2	400	-	400	0.2	-
Acetochlor	-	-	1.7	-	-	-	1.6	-
Alachlor	-	-	1	-	-	-	2	-
Aldicarb	-	0.5	-	0.5	-	-	-	-
Alpha-cypermethrin	-	10	-	10	-	-	-	-
Aluminum phosphide	-	-	-	-	-	-	-	-
Aminocyclopyrachlor	-	-	-	150	-	150	-	-
Aminopyralid	-	0.3	-	3	-	70	-	-
Atrazine	-	-	0.5	-	-	-	0.25	-
Azoxystrobin	-	30	40	30	-	-	25	-
Benoxacor	-	-	0.01	-	-	-	0.01	-
Bentazon	-	-	0.05	2	-	2	0.2	-
Beta-cyfluthrin	7	-	30	-	6	-	25	-
Beta-cypermethrin	-	10	-	10	-	-	-	-
Boscalid	-	5	-	5	-	-	-	-
Bromoxynil	-	-	0.2	-	-	-	0.8	-
Captan	0.05	-	0.05	-	-	-	0.05	-
Carbaryl	-	-	30	-	-	-	30	50
Carbofuran	-	0.5	-	0.5	-	-	-	-
Carfentrazone-ethyl	3	-	0.8	-	0.3	-	1	-
Chlorantraniliprole	40	0.3	40	0.3	-	-	40	-
Chlormequat	-	30	-	30	-	-	-	-
Chlorpyrifos	-	2	2	2	-	-	0.5	-
Chlorpyrifos-methyl	0.05	-	0.1	-	0.07	-	0.35	-
Clothianidin	-	0.01	-	0.01	-	-	-	-
Cyantraniliprole	-	0.2	-	0.2	-	0.2	-	-
Cyfluthrin	7	-	30	-	6	-	25	-
Cyhalothrin	-	2	-	2	-	-	-	-
Cypermethrin	-	10	-	10	-	-	-	-
Cyproconazole	-	5	-	5	-	-	-	-
Cyprodinil	-	10	-	10	-	-	-	-
Deltamethrin	-	-	1	-	-	-	0.5	-
Dicamba	-	8	10	8	-	30	3	-
Dichlobenil	-	0.4	-	0.4	-	-	-	-
Dichlormid	-	-	0.05	-	-	-	0.05	-
Diflubenzuron	-	1.5	-	1.5	-	3	-	-
Dimethenamid	-	0.01	0.01	0.01	-	-	0.01	-
Dimethenamid-p	-	0.01	0.01	0.01	-	-	0.01	-
Dimethoate	-	-	0.1	-	-	-	0.1	-

Table 17. Tolerances established on Forage, Fodder and Straw of Cereal Grains (continued)
(Data provided by Bryant Christie Inc. on January 6, 2017; note that shading indicates a crop definition, group or subgroup tolerance); MRLs in parentheses are more restrictive than the US MRL.

	Sorghum, straw (ppm)		Sorghum, fodder (ppm)		Sorghum, hay (ppm)		Sorghum, forage (ppm)	
Compound	US	Codex	US	Codex	US	Codex	US	Codex
Diquat dibromide	0.02	-	0.02	-	-	-	0.02	-
Diuron	-	-	2	-	-	-	2	-
Esfenvalerate	-	-	10	-	-	-	10	-
Flubendiamide	-	-	14	-	-	-	12	-
Fludioxonil	0.1	0.06	0.1	0.06	-	-	0.1	-
Fluopicolide	-	0.2	-	0.2	-	-	-	-
Fluopyram	20	-	20	-	-	-	20	-
Fluoride	-	-	-	-	-	-	-	-
Fluoxastrobin	-	-	5	-	-	-	5	-
Flupyradifurone	30	-	30	-	-	-	30	-
Fluroxypyr	-	-	4	-	-	-	2	-
Fluroxypyr-meptyl	-	-	4	-	-	-	2	-
Flusilazole	-	5	-	5	-	-	-	-
Flutriafol	-	7	6	7	-	-	2	-
Fluxapyroxad	20	7	20	7	-	-	20	-
Furilazole	-	-	0.01	-	-	-	0.01	-
Gamma cyhalothrin	-	2	0.5	2	-	-	0.3	-
Glyphosate	-	50	100	50	-	500	-	-
Halosulfuron-methyl	-	-	0.1	-	-	-	0.05	-
Hexythiazox	-	-	6	-	-	-	5	-
Imazapic-ammonium	-	-	-	3	-	3	-	-
Imazapyr	-	-	-	6	-	6	-	-
Imidacloprid	3	-	0.3	-	6	-	7	-
Inorganic bromide resulting from fumigation with methyl bromide	-	-	-	-	-	-	-	-
Ipconazole	0.01	-	0.01	-	-	-	0.01	-
Kresoxim-methyl	-	5	-	5	-	-	-	-
Lambda cyhalothrin	-	2	0.5	2	-	-	0.3	-
Lindane	-	0.01	-	0.01	-	-	-	-
Linuron	-	-	1	-	-	-	1	-
Magnesium phosphide	-	-	-	-	-	-	-	-
Malathion	-	-	-	-	-	-	8	-
Mancozeb	-	-	0.15	-	-	-	0.15	-
MCPA	-	-	-	500	-	500	-	-
Mefenpyr-diethyl	-	-	0.2	-	-	-	0.4	-
Mesotrione	-	-	0.01	-	-	-	0.01	-
Methomyl	-	10	-	10	-	10	1	-
Methoxyfenozide	-	-	20	-	-	-	15	-
Metolachlor	-	-	4	-	-	-	1	-

Table 17. Tolerances established on Forage, Fodder and Straw of Cereal Grains (continued)
(Data provided by Bryant Christie Inc. on January 6, 2017; note that shading indicates a crop definition, group or subgroup tolerance); MRLs in parentheses are more restrictive than the US MRL.

	Sorghum, straw (ppm)		Sorghum, fodder (ppm)		Sorghum, hay (ppm)		Sorghum, forage (ppm)	
Compound	US	Codex	US	Codex	US	Codex	US	Codex
Metsulfuron-methyl	-	-	0.2	-	-	-	0.2	-
Myclobutanil	-	0.3	-	0.3	-	-	-	-
Nicosulfuron	-	-	0.05	-	-	-	0.3	-
Nitrapyrin	-	-	0.5	-	-	-	0.5	-
Novaluron	-	-	40	-	-	-	6	-
Omethoate	-	-	0.1	-	-	-	0.1	-
Oxydemeton-methyl	-	-	-	-	-	-	2	-
Paraquat dichloride	-	0.3	-	0.3	-	-	0.1	-
Pendimethalin	-	-	0.1	2500	-	2500	0.1	-
Penflufen	0.1	-	0.1	-	-	-	0.1	-
Penthiopyrad	-	10	15	10	-	-	40	-
Permethrin	-	20	-	20	-	-	-	-
Phorate	-	-	0.1	-	-	-	-	-
Phosphine	-	-	-	-	-	-	-	-
Picoxystrobin	2	-	10	-	5	-	15	-
Piperonyl butoxide	-	-	-	-	-	-	-	-
Pirimicarb	-	0.3	-	0.3	-	-	-	-
Pirimiphos-methyl	-	-	-	-	-	-	-	-
Prochloraz	-	40	-	40	-	-	-	-
Propachlor	-	-	12	-	-	-	8	-
Propargite	-	-	10	-	-	-	10	-
Propazine	-	-	-	-	-	-	0.25	-
Prothioconazole	-	-	15	-	-	-	12	-
Prosulfuron	0.02	-	0.01	-	0.2	-	0.1	-
Prothioconazole	-	4	-	5	-	-	-	-
Pyraclostrobin	-	30	0.8	30	-	-	5	-
Pyrasulfotole	-	-	0.8	-	-	-	1.5	-
Pyrethrins	-	-	-	-	-	-	-	-
Pyriproxyfen	1.1	-	1.1	-	-	-	1.1	-
Quinclorac	-	-	1	-	-	-	3	-
Quizalofop-ethyl	-	-	0.3	-	-	-	0.2	-
Rimsulfuron	-	-	0.01	-	-	-	0.01	-
Saflufenacil	0.1	0.05	0.1	0.05	-	-	0.1	-
Sedaxane	0.06	0.1	0.01	0.1	-	0.1	0.01	-
S-metolachlor	-	-	4	-	-	-	1	-
Spinetoram	1	-	10	-	10	-	3.5	-
Spinosad	1	-	10	-	10	-	2.5	-
Sulfoxaflor	-	-	0.9	-	-	-	0.4	-
Sulfuryl fluoride	-	-	-	-	-	-	-	-

Table 17. Tolerances established on Forage, Fodder and Straw of Cereal Grains (continued)
(Data provided by Bryant Christie Inc. on January 6, 2017; note that shading indicates a crop definition, group or subgroup tolerance); MRLs in parentheses are more restrictive than the US MRL.

	Sorghum, straw (ppm)		Sorghum, fodder (ppm)		Sorghum, hay (ppm)		Sorghum, forage (ppm)	
Compound	US	Codex	US	Codex	US	Codex	US	Codex
2-(Thiocyanomethylthio)benzothiazole	-	-	0.1	-	-	-	-	-
Terbufos	-	0.3	0.5	0.3	-	-	0.5	-
Thiamethoxam	-	-	0.02	-	-	-	0.02	-
Thifensulfuron-methyl	-	-	0.05	-	-	-	0.05	-
Thiodicarb	-	10	-	10	-	-	-	10
Triadimefon	-	5	-	5	-	-	-	-
Triadimenol	-	5	-	5	-	-	-	-
Tribenuron methyl	-	-	0.05	-	-	-	0.05	-
Trifluralin	-	-	0.05	-	-	-	0.05	-
Triticonazole	0.1	-	0.1	-	-	-	0.1	-
Zeta-cypermethrin	-	10	5	10	-	-	0.1	-

Table 17. Tolerances established on Forage, Fodder and Straw of Cereal Grains (continued)
(Data provided by Bryant Christie Inc. on January 6, 2017; note that shading indicates a crop definition, group or subgroup tolerance); MRLs in parentheses are more restrictive than the US MRL.

	Teosinte, straw (ppm)		Teosinte, fodder (ppm)		Teosinte, hay (ppm)		Teosinte, forage (ppm)	
Compound	US	Codex	US	Codex	US	Codex	US	Codex
2,4-D	-	-	-	400	-	400	-	-
Acetochlor	-	-	-	0.3	-	-	-	-
Alpha-cypermethrin	-	10	-	10	-	-	-	-
Aminocyclopyrachlor	-	-	-	150	-	150	-	-
Aminopyralid	-	0.3	-	3	-	70	-	-
Azoxystrobin	-	15	-	15	-	-	-	-
Bentazon	-	-	-	2	-	2	-	-
Beta-cyfluthrin	7	-	30	-	6	-	25	-
Beta-cypermethrin	-	10	-	10	-	-	-	-
Boscalid	-	5	-	5	-	-	-	-
Captan	0.05	-	0.05	-	-	-	0.05	-
Carfentrazone-ethyl	3	-	0.8	-	0.3	-	1	-
Chlorantraniliprole	40	0.3	40	0.3	-	-	40	-
Chlormequat	-	30	-	30	-	-	-	-
Clothianidin	0.05	-	0.1	-	0.07	-	0.35	-
Cyantraniliprole	-	0.2	-	0.2	-	0.2	-	-
Cyfluthrin	7	-	30	-	6	-	25	-
Cyhalothrin	-	2	-	2	-	-	-	-
Cypermethrin	-	10	-	10	-	-	-	-
Cyproconazole	-	5	-	5	-	-	-	-
Cyprodinil	-	10	-	10	-	-	-	-
Dicamba	-	-	-	30	-	30	-	-
Dichlobenil	-	0.4	-	0.4	-	-	-	-
Diflubenzuron	-	1.5	-	1.5	-	3	-	-
Diquat dibromide	0.02	-	0.02	-	-	-	0.02	-
Fludioxonil	0.01	0.06	0.01	0.06	-	-	0.01	-
Fluopicolide	-	0.2	-	0.2	-	-	-	-
Fluopyram	20	-	20	-	-	-	20	-
Flupyradifurone	30	-	30	-	-	-	30	-
Flusilazole	-	5	-	5	-	-	-	-
Fluxapyroxad	20	-	20	-	-	-	20	-
Gamma cyhalothrin	-	2	-	2	-	-	-	-
Glyphosate	-	-	100	500	-	500	-	-
Imazapic-ammonium	-	-	-	3	-	3	-	-
Imazapyr	-	-	-	6	-	6	-	-
Imidacloprid	3	-	0.3	-	6	-	7	-
Ipconazole	0.01	-	0.01	-	-	-	0.01	-
Kresoxim-methyl	-	5	-	5	-	-	-	-

Table 17. Tolerances established on Forage, Fodder and Straw of Cereal Grains (continued)
(Data provided by Bryant Christie Inc. on January 6, 2017; note that shading indicates a crop definition, group or subgroup tolerance); MRLs in parentheses are more restrictive than the US MRL.

	Teosinte, straw (ppm)		Teosinte, fodder (ppm)		Teosinte, hay (ppm)		Teosinte, forage (ppm)	
Compound	US	Codex	US	Codex	US	Codex	US	Codex
Lambda cyhalothrin	-	2	-	2	-	-	-	-
Lindane	-	0.01	-	0.01	-	-	-	-
MCPA	-	500	-	500	-	-	-	-
Methomyl	-	10	-	10	-	10	-	-
Myclobutanil	-	0.3	-	0.3	-	-	-	-
Penflufen	0.01	-	0.01	-	-	-	0.01	-
Picoxystrobin	2	-	10	-	5	-	15	-
Pirimicarb	-	0.3	-	0.3	-	-	-	-
Prochloraz	-	40	-	40	-	-	-	-
Prosulfuron	0.02	-	0.01	-	0.2	-	0.1	-
Prothioconazole	5	4	10	5	7	-	8	-
Pyraclostrobin	-	30	-	30	-	-	-	-
Pyriproxyfen	1.1	-	1.1	-	-	-	1.1	-
Saflufenacil	0.1	-	0.1	-	-	-	0.1	-
Sedaxane	0.1	-	0.1	-	0.1	-	-	-
Spinetoram	1	-	10	-	10	-	3.5	-
Spinosad	1	-	10	-	10	-	2.5	-
Tetraconazole	8	-	8	-	-	-	8	-
Thiodicarb	-	10	-	10	-	10	-	-
Triadimefon	-	5	-	5	-	-	-	-
Triadimenol	-	5	-	5	-	-	-	-
Triticonazole	0.1	-	0.1	-	-	-	0.1	-
Zeta-cypermethrin	-	10	-	10	-	-	-	-

Table 17. Tolerances established on Forage, Fodder and Straw of Cereal Grains (continued)
(Data provided by Bryant Christie Inc. on January 6, 2017; note that shading indicates a crop definition, group or subgroup tolerance); MRLs in parentheses are more restrictive than the US MRL.

	Triticale, straw (ppm)		Triticale, fodder (ppm)		Triticale, hay (ppm)		Triticale, forage (ppm)	
Compound	US	Codex	US	Codex	US	Codex	US	Codex
2,4-D	-	-	-	400	-	400	-	-
Alpha-cypermethrin	-	10	-	10	-	-	-	-
Aminocyclopyrachlor	-	-	-	150	-	150	-	-
Aminopyralid	-	0.3	-	3	-	70	-	-
Azoxystrobin	-	15	-	15	-	-	-	-
Bentazon	-	0.3	-	0.3	-	2	-	-
Beta-cyfluthrin	7	-	30	-	6	-	25	-
Beta-cypermethrin	-	10	-	10	-	-	-	-
Bitertanol	-	0.05	-	0.05	-	-	-	-
Boscalid	-	5	-	5	-	-	-	-
Captan	0.05	-	0.05	-	-	-	0.05	-
Carfentrazone-ethyl	3	-	0.8	-	0.3	-	1	-
Chlorantraniliprole	40	0.3	40	0.3	-	-	40	-
Chlormequat	-	30	-	30	-	-	-	-
Clothianidin	0.05	-	0.1	-	0.07	-	0.35	-
Cyantraniliprole	-	0.2	-	0.2	-	0.2	-	-
Cyfluthrin	7	-	30	-	6	-	25	-
Cyhalothrin	-	2	-	2	-	-	-	-
Cypermethrin	-	10	-	10	-	-	-	-
Cyproconazole	-	5	-	5	-	-	-	-
Cyprodinil	-	10	-	10	-	-	-	-
Dicamba	-	-	-	30	-	30	-	-
Dichlobenil	-	0.4	-	0.4	-	-	-	-
Diflubenzuron	-	1.5	-	1.5	-	3	-	-
Diquat dibromide	0.02	-	0.02	-	-	-	0.02	-
Ethephon	-	7	-	7	-	-	-	-
Fludioxonil	0.01	0.06	0.01	0.06	-	-	0.01	-
Fluopicolide	-	0.2	-	0.2	-	-	-	-
Fluopyram	20	-	20	-	-	-	20	-
Flupyradifurone	30	-	30	-	-	-	30	-
Flusilazole	-	5	-	5	-	-	-	-
Fluxapyroxad	20	30	20	30	-	-	20	-
Gamma cyhalothrin	-	2	-	2	-	-	-	-
Glyphosate	-	-	100	500	-	500	-	-
Imazapic-ammonium	-	-	-	3	-	3	-	-
Imazapyr	-	-	-	6	-	6	-	-
Imidacloprid	3	-	0.3	-	6	-	7	-
Ipconazole	0.01	-	0.01	-	-	-	0.01	-

Table 17. Tolerances established on Forage, Fodder and Straw of Cereal Grains (continued)
(Data provided by Bryant Christie Inc. on January 6, 2017; note that shading indicates a crop definition, group or subgroup tolerance); MRLs in parentheses are more restrictive than the US MRL.

	Triticale, straw (ppm)		Triticale, fodder (ppm)		Triticale, hay (ppm)		Triticale, forage (ppm)	
Compound	US	Codex	US	Codex	US	Codex	US	Codex
Isopyrazam	-	3	-	3	-	-	-	-
Kresoxim-methyl	-	5	-	5	-	-	-	-
Lambda cyhalothrin	-	2	-	2	-	-	-	-
Lindane	-	0.01	-	0.01	-	-	-	-
MCPA	-	-	-	50	-	50	-	-
Methomyl	-	10	-	10	-	10	-	-
Metrafenone	-	10	-	10	-	-	-	-
Myclobutanil	-	0.3	-	0.3	-	-	-	-
Penflufen	0.01	-	0.01	-	-	-	0.01	-
Penthiopyrad	1	80	80	80	80	-	40	-
Picoxystrobin	2	-	10	-	5	-	15	-
Pirimicarb	-	0.3	-	0.3	-	-	-	-
Prochloraz	-	40	-	40	-	-	-	-
Propiconazole	-	15	-	15	-	-	-	-
Prosulfuron	0.02	-	0.01	-	0.2	-	0.1	-
Prothioconazole	5	4	10	5	7	-	8	-
Pyraclostrobin	-	30	-	30	-	-	-	-
Pyriproxyfen	1.1	-	1.1	-	-	-	1.1	-
Saflufenacil	0.1	-	0.1	-	-	-	0.1	-
Sedaxane	0.1	-	0.1	-	0.1	-	-	-
Spinetoram	1	-	10	-	10	-	3.5	-
Spinosad	1	-	10	-	10	-	2.5	-
Tetraconazole	8	-	8	-	-	-	8	-
Thiabendazole	0.3	-	-	-	0.3	-	0.3	-
Thiodicarb	-	10	-	10	-	10	-	-
Triadimefon	-	5	-	5	-	-	-	-
Triadimenol	-	5	-	5	-	-	-	-
Triticonazole	0.1	-	0.1	-	-	-	0.1	-
Zeta-cypermethrin	-	10	-	10	-	-	-	-

Table 17. Tolerances established on Forage, Fodder and Straw of Cereal Grains (continued)
(Data provided by Bryant Christie Inc. on January 6, 2017; note that shading indicates a crop definition, group or subgroup tolerance); MRLs in parentheses are more restrictive than the US MRL.

	Wheat, straw (ppm)		Wheat, fodder (ppm)		Wheat, hay (ppm)		Wheat, forage (ppm)	
Compound	US	Codex	US	Codex	US	Codex	US	Codex
2,4-D	50	100	-	400	-	400	25	-
Acetochlor	-	0.2	-	0.2	-	-	-	-
Aldicarb	-	0.05	-	0.05	-	-	-	-
Alpha-cypermethrin	-	10	-	10	-	-	-	-
Aminocyclopyrachlor	-	-	-	150	-	150	-	-
Aminopyralid	0.25	0.3	-	3	4	70	2	-
Atrazine	0.5	-	-	-	5	-	1.5	-
Azoxystrobin	10	15	-	15	30	-	15	-
Benomyl	-	1	-	1	-	-	-	-
Bentazon	-	0.3	-	0.3	-	2	-	-
Benzovindiflupyr	15	-	-	-	15	-	4	-
Beta-cyfluthrin	7	-	30	-	6	-	25	-
Beta-cypermethrin	-	10	-	10	-	-	-	-
Bicyclopyrone	0.5	-	-	-	0.8	-	0.4	-
Bitertanol	-	0.05	-	0.05	-	-	-	-
Boscalid	-	50	-	50	-	-	-	-
Bromoxynil	2	-	-	-	4	-	1	-
Captan	0.05	-	0.05	-	-	-	0.05	-
Carbaryl	20	30	-	30	30	-	30	-
Carbendazim	-	1	-	1	-	-	-	-
Carbon disulfide	-	25	-	25	-	-	-	-
Carboxin	0.2	-	-	-	-	-	0.5	-
Carfentrazone-ethyl	3	-	0.8	-	0.3	-	1	-
Chlorantraniliprole	40	0.3	40	0.3	-	-	40	-
Chlormequat	-	30	-	30	-	-	-	-
Chlorpyrifos	6	5	-	5	-	-	3	-
Chlorsulfuron	0.5	-	-	-	-	-	20	-
Clodinafop-propargyl	0.5	-	-	-	0.1	-	0.1	-
Clopyralid	9	-	-	-	-	-	9	-
Cloquintocet-mexyl	0.1	-	-	-	0.5	-	0.2	-
Clothianidin	0.05	0.2	0.1	0.2	0.07	-	0.35	-
Cyantraniliprole	-	0.2	-	0.2	-	0.2	-	-
Cyfluthrin	7	-	30	-	6	-	25	-
Cyhalothrin	-	2	-	2	-	-	-	-
Cypermethrin	-	10	-	10	-	-	-	-
Cyproconazole	0.9	5	-	5	1.3	-	0.8	-
Cyprodinil	-	10	-	10	-	-	-	-
Dicamba	30	50	-	50	40	30	90	-

Table 17. Tolerances established on Forage, Fodder and Straw of Cereal Grains (continued)
(Data provided by Bryant Christie Inc. on January 6, 2017; note that shading indicates a crop definition, group or subgroup tolerance); MRLs in parentheses are more restrictive than the US MRL.

	Wheat, straw (ppm)		Wheat, fodder (ppm)		Wheat, hay (ppm)		Wheat, forage (ppm)	
Compound	US	Codex	US	Codex	US	Codex	US	Codex
Dichlobenil	-	0.4	-	0.4	-	-	-	-
Diclofop-methyl	0.1	-	-	-	-	-	-	-
Difenoconazole	0.1	3	-	3	0.05	-	0.1	-
Diflubenzuron	3.5	1.5	-	1.5	6	3	7	-
Dimethoate	2	1	-	1	2	-	2	-
Diquat dibromide	0.02	-	0.02	-	-	-	0.02	-
Disulfoton	-	5	-	5	-	-	-	-
Diuron	1.5	-	-	-	2	-	2	-
Esfenvalerate	-	2	-	2	-	-	-	-
Ethephon	10	7	-	7	-	-	-	-
Famoxadone	-	7	-	7	-	-	-	-
Fenbuconazole	8	3	-	3	8	-	4	-
Fenoxaprop-ethyl	0.5	-	-	-	-	-	-	-
Fenoxaprop-p-ethyl	0.5	-	-	-	-	-	-	-
Fenpropimorph	-	5	-	5	-	-	-	-
Ferbam	-	25	-	25	-	-	-	-
Florasulam	0.05	-	-	-	0.05	-	0.05	-
Flucarbazone-sodium	0.05	-	-	-	0.1	-	0.3	-
Fludioxonil	0.01	0.06	0.01	0.06	-	-	0.01	-
Flufenacet	0.35	-	-	-	1.2	-	6	-
Flumioxazin	6	7	-	7	0.02	0.02	0.02	-
Fluopicolide	-	0.2	-	0.2	-	-	-	-
Fluopyram	20	-	20	-	-	-	20	-
Fluoxastrobin	11	-	-	-	17	-	7	-
Flupyradifurone	30	-	30	-	-	-	30	-
Fluroxypyr	12	-	-	-	20	-	12	-
Fluroxypyr-meptyl	12	-	-	-	20	-	12	-
Flusilazole	-	5	-	5	-	-	-	-
Flutriafol	9	8	-	8	15	-	30	-
Fluxapyroxad	20	30	20	30	-	-	20	-
Gamma cyhalothrin	-	2	-	2	2	-	2	-
Glyphosate	-	300	100	300	-	500	-	-
Halauxifen-methyl	0.015	-	-	-	0.03	-	0.5	-
Hexythiazox	8	-	-	-	30	-	6	-
Imazalil	0.5	0.1	-	0.1	0.5	-	0.5	-
Imazamox	-	0.05	-	0.05	-	-	-	-
Imazapic-ammonium	-	0.05	-	0.05	-	3	-	-
Imazapyr	-	0.05	-	6	-	0.05	-	-

Table 17. Tolerances established on Forage, Fodder and Straw of Cereal Grains (continued)
(Data provided by Bryant Christie Inc. on January 6, 2017; note that shading indicates a crop definition, group or subgroup tolerance); MRLs in parentheses are more restrictive than the US MRL.

	Wheat, straw (ppm)		Wheat, fodder (ppm)		Wheat, hay (ppm)		Wheat, forage (ppm)	
Compound	US	Codex	US	Codex	US	Codex	US	Codex
Imidacloprid	3	-	0.3	-	6	-	7	-
Ipconazole	-	1	-	1	-	-	-	-
Iodosulfuron-methyl	0.05	-	-	-	0.05	-	0.1	-
Ipconazole	0.01	-	0.01	-	-	-	0.01	-
Isopyrazam	-	3	-	3	-	-	-	-
Kresoxim-methyl	-	5	-	5	-	-	-	-
Lambda cyhalothrin	2	2	-	2	2	-	2	-
Lindane	-	0.01	-	0.01	-	-	-	-
Linuron	2	-	-	-	0.5	-	0.5	-
Malathion	50	-	-	-	-	-	4	-
Mancozeb	25	25	-	25	30	-	-	-
Maneb	-	25	-	25	-	-	-	-
MCPA	25	50	-	50	115	500	20	-
Mefenpyr-diethyl	0.5	-	-	-	0.2	-	0.2	-
Mesosulfuron-methyl	0.3	-	-	-	0.06	-	0.6	-
Metaldehyde	0.05	-	-	-	0.05	-	0.05	-
Metconazole	18	-	-	-	16	-	-	-
Methiocarb	-	0.05	-	0.05	-	-	-	-
Methomyl	10	5	-	5	10	10	10	-
Metiram	-	25	-	25	-	-	-	-
Metrafenone	-	10	-	10	-	-	-	-
Metribuzin	1	-	-	-	7	-	2	-
Metsulfuron-methyl	0.3	-	-	-	20	-	5	-
Myclobutanil	-	0.3	-	0.3	-	-	-	-
Nitrapyrin	6	-	-	-	-	-	2	-
Omethoate	2	-	-	-	2	-	2	-
Oxydemeton-methyl	-	0.1	-	0.1	-	-	-	-
Paraquat dichloride	50	-	-	-	3.5	-	0.5	-
Pendimethalin	0.3	-	-	-	0.6	-	3	-
Penflufen	0.01	-	0.01	-	-	-	0.01	-
Pentachloronitrobenzene	-	0.03	-	0.03	-	-	-	-
Penthiopyrad	1	80	-	80	80	-	40	-
Phorate	0.05	-	-	-	1.5	-	1.5	-
Picloram	1	-	-	-	-	-	1	-
Picoxystrobin	2	-	10	-	5	-	15	-
Pinoxaden	1.5	-	-	-	2	-	3.5	-
Pirimicarb	-	0.3	-	0.3	-	-	-	-
Prochloraz	-	40	-	40	-	-	-	-

Table 17. Tolerances established on Forage, Fodder and Straw of Cereal Grains (continued)
(Data provided by Bryant Christie Inc. on January 6, 2017; note that shading indicates a crop definition, group or subgroup tolerance); MRLs in parentheses are more restrictive than the US MRL.

	Wheat, straw (ppm)		Wheat, fodder (ppm)		Wheat, hay (ppm)		Wheat, forage (ppm)	
Compound	US	Codex	US	Codex	US	Codex	US	Codex
Propiconazole	20	15	-	15	30	-	15	-
Propineb	-	25	-	25	-	-	-	-
Propoxycarbazone	0.05	-	-	-	0.15	-	17	-
Prosulfuron	0.02	-	0.01	-	0.2	-	0.1	-
Prothioconazole	5	4	10	5	7	-	8	-
Pyraclostrobin	8.5	30	-	30	6	-	-	-
Pyraflufen-ethyl	0.01	-	-	-	0.01	-	0.02	-
Pyrasulfotole	0.2	-	-	-	0.8	-	0.2	-
Pyriproxyfen	1.1	-	1.1	-	-	-	1.1	-
Pyroxasulfone	0.6	-	-	-	1	-	6	-
Pyroxsulam	0.03	-	-	-	0.01	-	0.06	-
Quinclorac	0.1	-	-	-	0.5	-	1	-
Quizalofop-ethyl	0.05	-	-	-	0.05	-	0.05	-
Saflufenacil	6	0.05	-	0.05	-	-	-	-
Sedaxane	0.01	0.1	-	0.1	0.06	0.1	0.015	-
Spinetoram	1	-	10	-	10	-	3.5	-
Spinosad	1	1	10	1	10	-	2.5	-
Sulfentrazone	1.5	-	-	-	0.3	-	0.5	-
Sulfosulfuron	0.1	-	-	-	0.3	-	4	-
Sulfoxaflor	2	3	-	3	1.5	-	1	-
2-(Thiocyanomethylthio)benzothiazole	0.1	-	-	-	0.1	-	0.1	-
Tebuconazole	1.5	40	-	40	7	-	3	-
Thiabendazole	0.3	-	-	-	0.3	-	0.3	-
Thiacloprid	-	5	-	5	-	-	-	-
Thiamethoxam	0.02	2	-	2	0.02	-	0.5	-
Thiencarbazone-methyl	0.01	-	-	-	0.01	-	0.1	-
Thifensulfuron-methyl	0.1	-	-	-	0.7	-	2.5	-
Thiodicarb	-	5	-	5	-	10	-	-
Thiophanate-methyl	0.1	1	-	1	0.1	-	1.1	-
Thiram	-	25	-	25	-	-	-	-
Triadimefon	-	5	-	5	-	-	-	-
Triadimenol	0.2	5	-	5	-	-	2.5	-
Tri-allate	1	-	-	-	1	-	0.5	-
Triasulfuron	2	-	-	-	-	-	5	-
Tribenuron methyl	0.1	-	-	-	0.5	-	0.3	-
Trifloxystrobin	5	5	-	5	0.2	-	0.3	-
Trifluralin	0.05	-	-	-	-	-	-	-
Trinexapac-ethyl	0.9	0.9	-	0.9	1.5	-	1	-

Table 17. Tolerances established on Forage, Fodder and Straw of Cereal Grains (continued)
(Data provided by Bryant Christie Inc. on January 6, 2017; note that shading indicates a crop definition, group or subgroup tolerance); MRLs in parentheses are more restrictive than the US MRL.

	Wheat, straw (ppm)		Wheat, fodder (ppm)		Wheat, hay (ppm)		Wheat, forage (ppm)	
Compound	US	Codex	US	Codex	US	Codex	US	Codex
Triticonazole	0.1	-	0.1	-	-	-	0.1	-
Zeta-cypermethrin	7	10	-	10	6	-	3	-
Zinc phosphide	0.05	-	-	-	0.05	-	0.05	-
Zineb	-	25	-	25	-	-	-	-
Ziram	-	25	-	25	-	-	-	-

Table 17. Tolerances established on Forage, Fodder and Straw of Cereal Grains (continued)
(Data provided by Bryant Christie Inc. on January 6, 2017; note that shading indicates a crop definition, group or subgroup tolerance); MRLs in parentheses are more restrictive than the US MRL.

	Wild rice, forage (ppm)		Wild rice, straw (ppm)		Wild rice, fodder (ppm)		Wild rice, hay (ppm)	
Compound	US	Codex	US	Codex	US	Codex	US	Codex
2,4-D	-	-	-	-	-	400	-	400
Alpha-cypermethrin	-	-	-	10	-	10	-	-
Aminocyclopyrachlor	-	-	-	-	-	150	-	150
Aminopyralid	-	-	-	0.3	-	3	-	70
Azoxystrobin	-	-	-	15	-	15	-	-
Benomyl	-	-	-	15	-	15	-	-
Bentazon	-	-	-	-	-	2	-	2
Beta-cyfluthrin	25	-	7	-	30	-	6	-
Beta-cypermethrin	-	-	-	10	-	10	-	-
Boscalid	-	-	-	5	-	5	-	-
Captan	0.05	-	0.05	-	0.05	-	-	-
Carfentrazone-ethyl	1	-	3	-	0.8	-	0.3	-
Chlorantraniliprole	40	-	40	0.3	40	0.3	-	-
Chlormequat	-	-	-	30	-	30	-	-
Clothianidin	0.35	-	0.05	-	0.1	-	0.07	-
Cyantraniliprole	-	-	-	0.2	-	0.2	-	0.2
Cyfluthrin	25	-	7	-	30	-	6	-
Cycloxydim	-	-	-	0.09	-	0.09	-	-
Cyhalothrin	-	-	-	2	-	2	-	-
Cypermethrin	-	-	-	10	-	10	-	-
Cyproconazole	-	-	-	5	-	5	-	-
Cyprodinil	-	-	-	10	-	10	-	-
Dicamba	-	-	-	-	-	30	-	30
Dichlobenil	-	-	-	0.4	-	0.4	-	-
Diflubenzuron	-	-	-	1.5	-	1.5	-	3
Dinotefuran	-	-	-	6	-	6	-	-
Diquat dibromide	0.02	-	0.02	-	0.02	-	-	-
Etofenprox	-	-	-	0.05	-	0.05	-	-
Fipronil	-	-	-	0.2	-	0.2	-	-
Fludioxonil	0.01	-	0.01	0.06	0.01	0.06	-	-
Fluopicolide	-	-	-	0.2	-	0.2	-	-
Fluopyram	20	-	20	-	20	-	-	-
Flupyradifurone	30	-	30	-	30	-	-	-
Flusilazole	-	-	-	5	-	5	-	-
Fluxapyroxad	20	-	20	-	20	-	-	-
Gamma cyhalothrin	-	-	-	2	-	2	-	-
Glyphosate	-	-	-	-	100	500	-	500
Imazapic-ammonium	-	-	-	-	-	3	-	3
Imazapyr	-	-	-	-	-	6	-	6

Table 17. Tolerances established on Forage, Fodder and Straw of Cereal Grains (continued)
(Data provided by Bryant Christie Inc. on January 6, 2017; note that shading indicates a crop definition, group or subgroup tolerance); MRLs in parentheses are more restrictive than the US MRL.

	Wild rice, forage (ppm)		Wild rice, straw (ppm)		Wild rice, fodder (ppm)		Wild rice, hay (ppm)	
Compound	US	Codex	US	Codex	US	Codex	US	Codex
Imidacloprid	7	-	3	-	0.3	-	6	-
Ipconazole	0.01	-	0.01	-	0.01	-	-	-
Kresoxim-methyl	-	-	-	5	-	5	-	-
Lambda cyhalothrin	-	-	-	2	-	2	-	-
Lindane	-	-	-	0.01	-	0.01	-	-
MCPA	-	-	-	-	-	500	-	500
Methomyl	-	-	-	10	-	10	-	10
Myclobutanil	-	-	-	0.3	-	0.3	-	-
Penflufen	0.01	-	0.01	-	0.01	-	-	-
Picoxystrobin	15	-	2	-	10	-	5	-
Pirimicarb	-	-	-	0.3	-	0.3	-	-
Prochloraz	-	-	-	40	-	40	-	-
Prosulfuron	0.1	-	0.02	-	0.01	-	0.2	-
Prothioconazole	8	-	5	4	10	5	7	-
Pyraclostrobin	-	-	-	30	-	30	-	-
Pyriproxyfen	1.1	-	1.1	-	1.1	-	-	-
Saflufenacil	0.1	-	0.1	-	0.1	-	-	-
Sedaxane	0.1	-	0.1	-	-	-	-	0.1
Spinetoram	3.5	-	1	-	10	-	10	-
Spinosad	2.5	-	1	-	10	-	10	-
Thiodicarb	-	-	-	10	-	10	-	10
Triadimefon	-	-	-	5	-	5	-	-
Triadimenol	-	-	-	5	-	5	-	-
Triticonazole	0.01	-	0.01	-	0.01	-	-	-
Zeta-cypermethrin	-	-	-	10	-	10	-	-

Appendix 3. Production

Table 2. NAFTA and World Cereal Grain Production (FAOSTAT)

Crop	**Total US Production (USDA/NASS acres harvested, 2007)**	**Total US Production (USDA/NASS acres harvested, 2012)**	**Total US Production (USDA/NASS, acres harvested, 2014)**	**Canada (FAOSTAT, acres harvested, 2014)**	**Mexico (FAOSTAT, acres harvested, 2014)**	**World Production - Countries**
Amaranth, Grain	--	--	--	--	--	Ethiopia, China, Bhutan, India, Nepal, Sri Lanka, Europe, Mexico, **United States**, Bolivia, Ecuador, Peru, and Argentina
Amaranth, Purple	--	--	--	--	--	Cultivated worldwide
Barley	3,502,000	3,283,905	2,497,000	5,278,303	774,990	In 2014, the highest production occurred in the Russian Federation, Australia, Ukraine, Turkey, Spain and **Canada**
Buckwheat	24,760	33,678	--	--	--	In 2014, the highest production occurred in the Russian Federation, China, mainland China, Ukraine, **United States** and Kazakhstan
Buckwheat, Tartary	--		--	--	--	Bhutan; India, Myanmar, Europe, **Canada**; Europe; **United**

Crop	Total US Production (USDA/NASS acres harvested, 2007)	Total US Production (USDA/NASS acres harvested, 2012)	Total US Production (USDA/NASS, acres harvested, 2014)	Canada (FAOSTAT, acres harvested, 2014)	Mexico (FAOSTAT, acres harvested, 2014)	World Production - Countries
						States
Canarygrass, Annual	--		--	264,891	136	In 2014, the highest production occurred in **Canada**, Argentina, Thailand, Australia and Uruguay
Canihua	None		None	--	--	Cultivated in the high Andes of Peru and Bolivia (GRIN). Grown at higher altitudes (up to 4,500 m) than quinoa
Chia	Production in Kentucky and Arizona			--	--	Australia is the world's top producer of chia. Other countries that grow chia commercially are Mexico, Bolivia, Peru, Argentina, Ecuador and Guatemala. Cultivated in Mexico and Guatemala
Corn, field	86,520,000	87,413,045	83,136,000	3,030,929	17,445,940	In 2014, the highest production (maize) occurred in China, mainland China, **United States**, Brazil, India, Mexico,

Crop	Total US Production (USDA/NASS acres harvested, 2007)	Total US Production (USDA/NASS acres harvested, 2012)	Total US Production (USDA/NASS, acres harvested, 2014)	Canada (FAOSTAT, acres harvested, 2014)	Mexico (FAOSTAT, acres harvested, 2014)	World Production - Countries
						Nigeria and Ukraine
Corn, popcorn	201,623	218,461	--	--	--	--
Corn, sweet corn	622,948	572,068	523,330	--	--	--
Cram-cram	--		--	--	--	Cultivated in India and Australia
Fonio, black	--		--	--	--	Africa
Fonio, white	--		--	--	--	In 2014, the highest production occurred in Guinea, Nigeria, Mali, Côte d'Ivoire and Burkina Faso
Huauzontle	--		--	--	--	Cultivated in Mexico (GRIN)
Inca wheat	--		--	--	--	Ethiopia, China, Bhutan, India, Nepal, **United States**, Argentina, Bolivia, Ecuador, Peru
Job's tears	--		--	--	--	Native to China, Taiwan, India, Indochina, Myanmar, Thailand, Malaysia, and the Philippines
Millet, Barnyard	--		--	--	--	Tanzania, China, Taiwan, India, Australia
Millet, Finger	--		--	--	--	Kenya; Tanzania; Uganda, Chad; Eritrea;

Crop	Total US Production (USDA/NASS acres harvested, 2007)	Total US Production (USDA/NASS acres harvested, 2012)	Total US Production (USDA/NASS, acres harvested, 2014)	Canada (FAOSTAT, acres harvested, 2014)	Mexico (FAOSTAT, acres harvested, 2014)	World Production - Countries
						Ethiopia; Somalia; Sudan, Algeria; Libya; Tunisia, Angola; Malawi; Mozambique; Zambia; Zimbabwe, Botswana; Namibia; South Africa, Mali; Niger; Nigeria; Senegal, Burundi; Cameroon; Central African Republic; Rwanda; Zaire, Madagascar, Oman, Armenia; Georgia, China, Japan; Taiwan, Afghanistan, Bhutan; India; Nepal; Pakistan; Sri Lanka, Indochina; Myanmar, Sumatra; Malaysia; Philippines, Western Australia
Millet, Foxtail	--		--	--	--	Widely cultivated, temperate and tropic
Millet, Little	--		--	--	--	China, India, Nepal, Pakistan, Sri Lanka,

Crop	Total US Production (USDA/NASS acres harvested, 2007)	Total US Production (USDA/NASS acres harvested, 2012)	Total US Production (USDA/NASS, acres harvested, 2014)	Canada (FAOSTAT, acres harvested, 2014)	Mexico (FAOSTAT, acres harvested, 2014)	World Production - Countries
						Myanmar, Malaysia, Philippines
Millet, Pearl	--		--	--	--	Africa, **United States**, China, India (GRIN). In 2014, the highest production of millet occurred in India, Niger, Sudan, Mali and Nigeria
Millet, Proso	520,000	205,000	430,000	--	840	In 2014, the highest production occurred in Niger, Sudan, Mali, Nigeria and Burkina Faso. Widely cultivated
Oat, Abyssinian	--		--	--	--	Ethiopia
Oat, Common	1,504,000	1,078,698	1,035,000	2,255,282	129,955	In 2014, the highest production occurred in Russian Federation, Canada, Australia, Poland and Spain
Oat, Naked	--		--	--	--	Europe
Oat, Sand	--		--	--	--	Lithuania, **United States (Indiana and Tennessee)**, United Kingdom, Brazil
Princess-feather	--		--	--	--	China, Bhutan, India, Nepal,

Crop	Total US Production (USDA/NASS acres harvested, 2007)	Total US Production (USDA/NASS acres harvested, 2012)	Total US Production (USDA/NASS, acres harvested, 2014)	Canada (FAOSTAT, acres harvested, 2014)	Mexico (FAOSTAT, acres harvested, 2014)	World Production - Countries
						Sri Lanka, Europe, Mexico, **United States**, Peru
Psyllium	--		--	--	--	Native to Africa, Asia-temperate, Asia=tropical and Europe
Psyllium, blond	--		--	--	--	Native to Africa, Asia-temperate, Asia=tropical and Europe
Quinoa	An estimated 500 acres in California (2016), with some additional production in Oregon, Washington and Colorado			--	--	Argentina, Chile, Bolivia, Columbia, Ecuador, Peru. In 2014, the highest production of quinoa occurred in Peru, Ecuador and Bolivia.
Rice	2,748,000	2,693,759	2,933,000	--	100,426	Throughout tropic, subtropic, & warm-temperate regions. In 2014 the highest production occurred in China, mainland China, Indonesia, Bangladesh and Thailand.
Rice, African	--	--	--	--	--	Cultivated in tropics

Crop	**Total US Production (USDA/NASS acres harvested, 2007)**	**Total US Production (USDA/NASS acres harvested, 2012)**	**Total US Production (USDA/NASS, acres harvested, 2014)**	**Canada (FAOSTAT, acres harvested, 2014)**	**Mexico (FAOSTAT, acres harvested, 2014)**	**World Production - Countries**
Rye	252,000	265,307	258,000	202,869	54	Widely cultivated. In 2014 the highest production occurred in Russian Federation, Poland, Germany, Belarus and China.
Sorghum, Grain	6,792,000	5,142,099	6,401,000	--	4,976,369	Cultivated throughout tropic, subtropic, & warm-temperate regions (GRIN). In 2014 highest production occurred in Sudan, India, Nigeria, Niger and **United States**
Teff	Grown in at least 25 states, mostly for forage, but there is increasing demand for the grain.	--		Ethiopia		
Teosinte	--			--		Native to Mexico and Guatemala
Triticale	49,636	61,428	--	32,123	11,915	In 2014, highest production occurred in Poland, Belarus,

Crop	Total US Production (USDA/NASS acres harvested, 2007)	Total US Production (USDA/NASS acres harvested, 2012)	Total US Production (USDA/NASS, acres harvested, 2014)	Canada (FAOSTAT, acres harvested, 2014)	Mexico (FAOSTAT, acres harvested, 2014)	World Production - Countries
						Germany, France and Russian Federation
Wheat, Club	--		--	--	--	Armenia, Azerbaijan, Kazakhstan, Kyrgyzstan, Tajikistan, Uzbekistan, Russian Federation, Egypt, Israel, Jordan, Lebanon, Syria, Turkey, Ukraine, Czech Republic, Germany, Slovakia, Norway, Italy, Romania)
Wheat, Common	50,999,000	49,040,276	46,385,000	23,380,355	1,746,036	Widely cultivated. In 2014, highest production occurred in India, China, mainland China, Russian Federation and **United States**).
Wheat, Durum	--		--	--	--	Only cultivated
Wheat, Einkorn	--		--	--	--	Only cultivated
Wheat, Emmer & Spelt	--	14,036	--	--	--	Only cultivated
Wheat, Macha	--		--	--	--	Georgia (Caucasus)
Wheat, Oriental	--		--	--	--	Armenia, Azerbaijan, Russian

Crop	Total US Production (USDA/NASS acres harvested, 2007)	Total US Production (USDA/NASS acres harvested, 2012)	Total US Production (USDA/NASS, acres harvested, 2014)	Canada (FAOSTAT, acres harvested, 2014)	Mexico (FAOSTAT, acres harvested, 2014)	World Production - Countries
						Federation, Uzbekistan, Iran
Wheat, Persian	--		--	--	--	Armenia, Azerbaijan, Georgia, Russian Federation, Iran, Iraq, Turkey
Wheat, Polish	--		--	--	--	Ethiopia, Algeria, Armenia, Azerbaijan, Georgia, Kazakhstan, Kyrgyzstan, Turkmenistan, Russian Federation, Turkey, Italy, Spain
Wheat, Poulard	--		--	--	--	Only cultivated
Wheat, Shot	--		--	--	--	Only cultivate
Wheat, Spelt	--		--	--	--	Only cultivated
Wheat, Timopheevi	--		--	--	--	Georgia (Caucasus)
Wheat, Vavilovi	--		--	--	--	Armenia, Azerbaijan, Turkey
Wheat, Wild einkorn	--		--	--	--	Native to Asia-temperate and Europe
Wheat, Wild emmer	--		--	--	--	Native to Asia-temperate
Wild rice	--	47,333	--	--	--	Naturalized, North America
Wild rice, Eastern	--	--	--	--	--	**Canada** (Quebec, Ontario) and **United States** (Alabama, Connecticut,

Crop	Total US Production (USDA/NASS acres harvested, 2007)	Total US Production (USDA/NASS acres harvested, 2012)	Total US Production (USDA/NASS, acres harvested, 2014)	Canada (FAOSTAT, acres harvested, 2014)	Mexico (FAOSTAT, acres harvested, 2014)	World Production - Countries
						Delaware, District of Columbia, Florida, Georgia, Illinois, Indiana, Iowa, Kentucky, Louisiana, Maryland, Massachusetts, Michigan, Minnesota, Mississippi, New Hampshire, New Jersey, New York, North Carolina, Ohio, Pennsylvania, Rhode Island, South Carolina, Vermont, Virginia, Wisconsin)